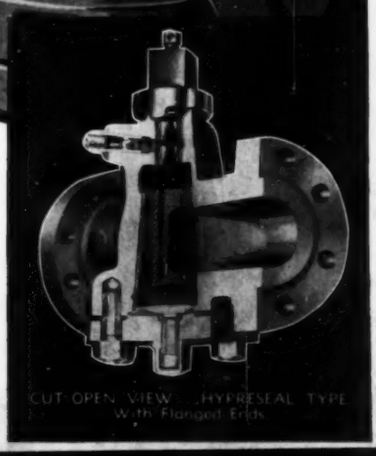
DRILLING
AND PRODUCTION

PIPE LINE

REFINING
NATURAL GASOLINE

NORDSTROM
HYPRESEAL
MUD LINE VALVES



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With Flanged Ends

MERCHROME COATED TO RESIST ABRASION

For mud line service the Nordstrom Merchrome Coated Valve outwears, outperforms any other valve. Its life is many times longer.

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Sizes 2", 3" and 4"
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Mud Line Bulletin upon request

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A Subsidiary of Pittsburgh Equitable Meter Co.
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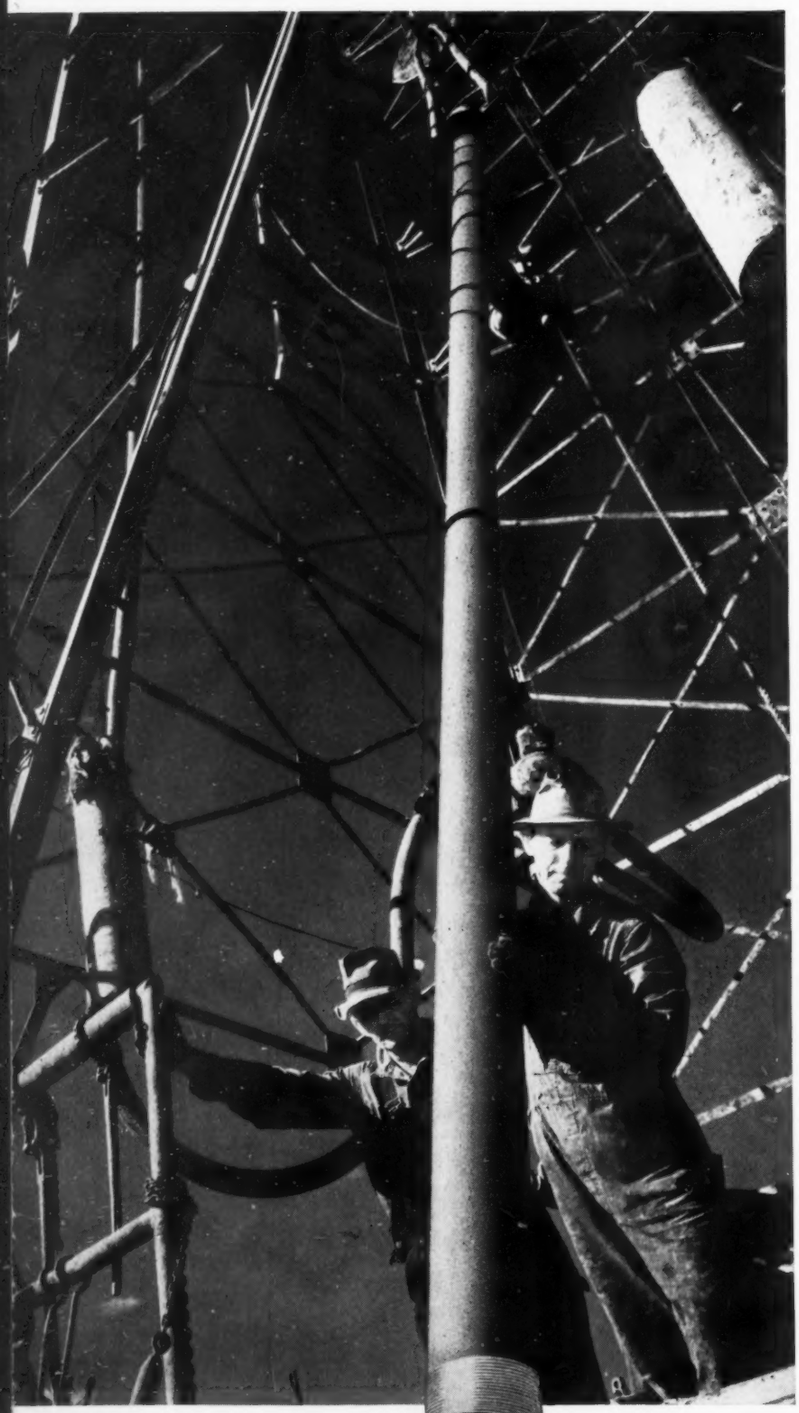
STRINGS OF STEEL—

that Help Shackle Aggression



• The strings of steel that lead to oil pools thousands of feet in the ground are arms of war power—strong arms, too. They deliver oil that gives action to our growing forces of motorized fighting equipment.

As our sea, air and land forces increase, so will their appetite for oil and gasoline. And the Oil Industry must be prepared to meet it. More casing and tubing will be needed. That calls for Steel—our share in the partnership of Oil and Steel in *Production for Victory.*

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It all has been done so we will be able to say "Yes" to demands for Steel for armaments—to the needs for Steel in all steps of Oil production.

Before you order casing, tubing or line pipe again, get a copy of the unusual 44-page book, "The Pipe of Progress." Read about the exclusive fabricating processes used and the advantages they produce in Republic Electric Weld Products. Get your copy now.

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in the Oklahoma City Area, world's toughest servicing job, and not one cent paid out for repairs!

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"Cardwell" rigs are field designed to do the job; they are constructed with alloy steels and specially reinforced to eliminate "dead weight"; and every wearing part, from the bolt holes in the drum ends to the last pin and pin hole in the controls, is heat-treated for wear resistance. These "hidden qualities" will save you the rig's purchase price in a few years.

"Cardwell" builds five standard skid type servicing hoists for well servicing from 2,000 to 12,000 feet. These hoists are available with single and double leg servicing masts. Write us for full information on a servicing hoist to fit your needs; or see our nearest representative.

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OIL WELL SERVICING
PHONE 2-2661
318 INSURANCE BUILDING
OKLAHOMA CITY

February 4, 1942

Cardwell Manufacturing Co., Inc.
P. O. 2001
Wichita, Kansas

Gentlemen:

Approximately twelve months ago I purchased one of your "Cardwell" Model S single drum servicing hoists and thought that you would like to have the information regarding the service this hoist has given me.

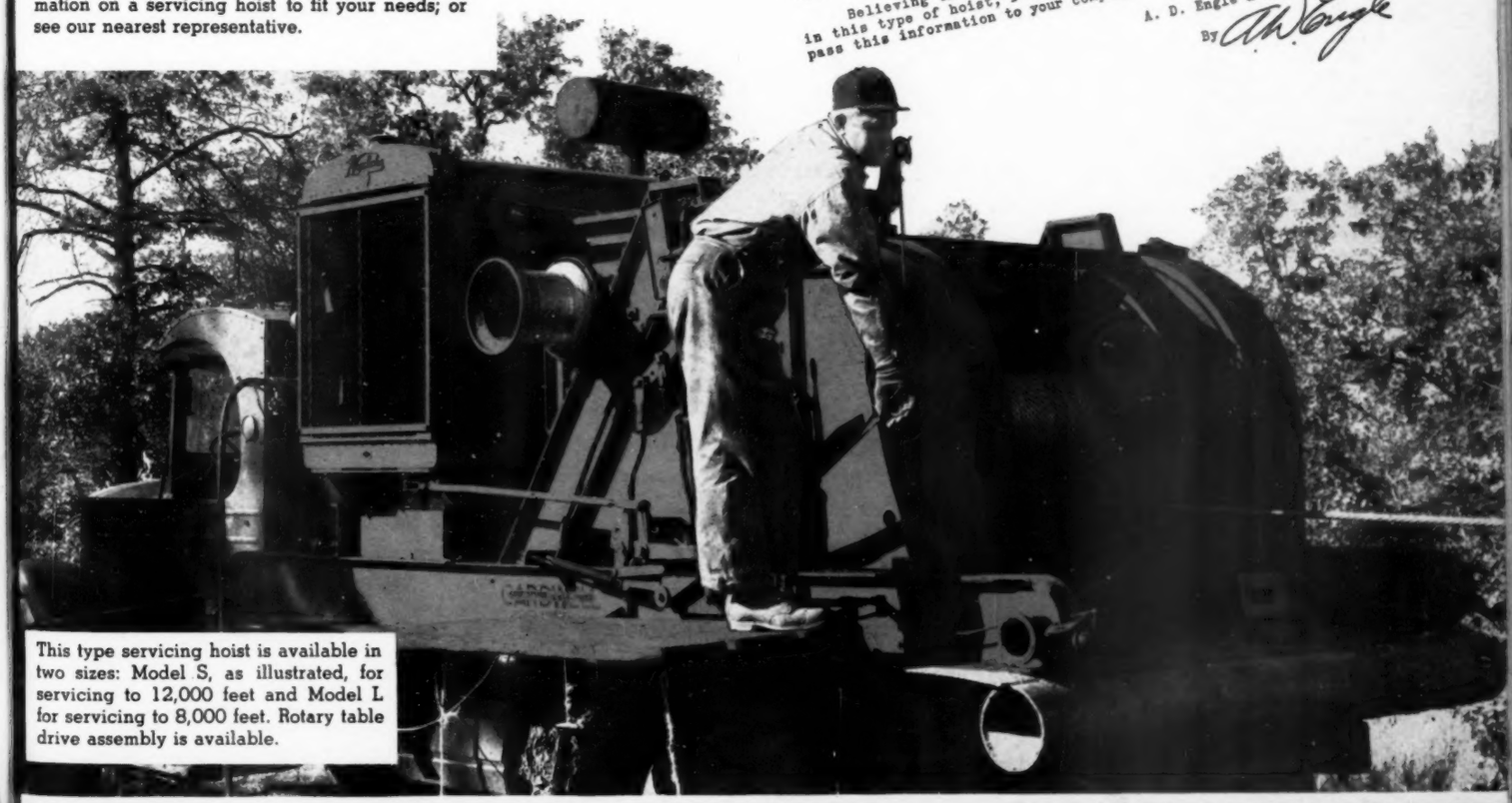
This hoist has been handling 7250 feet of 2½-inch tubing with Reda pump installation on four lines in the Moore district. The weight of tubing, Reda unit and cable, would be approximately 70,000 pounds, discounting any fluid that may be in the tubing. Also, it has handled 7250 feet of graduated rods: 3000 feet of 1-inch, 3000 feet of 7/8-inch, 1250 feet of 5/4-inch on single line.

On swabbing and bailing, this hoist has been highly satisfactory and my customers have been very well satisfied with the time that it has taken to do these different types of jobs.

To date I have not replaced or repaired any part of either the hoist or engine due to any difficulties in construction of this unit.

Believing that some of your customers might be interested in this type of hoist, I thought that it might be well if I pass this information to your company.

A. D. Engle & Company
By A. D. Engle



This type servicing hoist is available in two sizes: Model S, as illustrated, for servicing to 12,000 feet and Model L for servicing to 8,000 feet. Rotary table drive assembly is available.

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April, 1942

THE Petroleum Engineer

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Most of the 41 years of Youngstown's history have been years of peace. Like you, we look forward confidently to that day when steel can turn from its terrible work of destruction to the constructive task of restoring the foundations and rebuilding the structure of our national health and prosperity and happiness.

Victory when it comes must be unqualified, and complete. Victory calls for hard work—unstinted, total effort. So let us devote every machine and every ounce of manpower to the winning of the war. That is American Industry's task for TODAY——not tomorrow, but NOW.

THE YOUNGSTOWN SHEET AND TUBE COMPANY
YOUNGSTOWN, OHIO

25-31E

The Course of Oil

by K. C. SCLATER

OUR JOB

Under the title "Our Job on the Petroleum Front in Today's Battle", an address delivered before the Spring Meeting of the A.P.I. Mid-Continent District, Division of Production, last month, deals so pertinently with war conditions and attendant problems in the producing branch of the industry, and in indicating the effect thus far of Conservation Order M-68 on drilling operations, that the excerpts that follow merit the attention of oil men the country over.

In pre-war days the trend in producing operations was toward new and modern equipment. Throughout the last five or six years only a very small amount of old equipment has been used in either replacements or new developments. In the days of plenty, operators were "choosy" and particular, and suppliers were generous in providing materials and service on a guarantee basis, with return credit if materials proved unsuitable or unsatisfactory. It appears now that those days are gone, at least until the war is won.

Supplies are becoming scarce, and some equipment in the future will become a rarity. This war is a challenge to the ingenuity of producers throughout the nation. The time has come when we can no longer remain at the desk, fret about shortages of materials, or be disturbed by influences and restrictions in our business.

It is the producer's responsibility to get his job done with the materials that are available and to deliver a maximum amount of petroleum per ton of steel used in development and producing operations.

In despair some of us prefer to complain rather than to create and devise new means of overcoming our difficulties. This is a time for us to learn how we can operate under new difficulties. Our thoughts should be directed to maintaining oil production, not with the existing, but with a reduced personnel, so that we may release excess man-power for other war effort.

In the past we have been accustomed to drilling our oil wells when and where we pleased. With the responsibility upon our shoulders to conserve strategic and essential materials, we must readjust our drilling programs even at some sacrifice of our selfish interests. We should delay development and expansion programs in areas where available production exceeds transportation facilities. Development should be accelerated where the most oil can be obtained and delivered quickest into the war effort with the minimum consumption of steel. In order to win this war we may even be called upon to sacrifice some of the principles of conservation for which we have fought so valiantly during the past ten to twenty years.

The Petroleum Industry is responsible for supplying adequate oil in the proper form and in the proper places. Although only three months have elapsed since Conservation Order M-68 was issued we can now see clearly some of its effects; we may even predict future trends resulting therefrom.

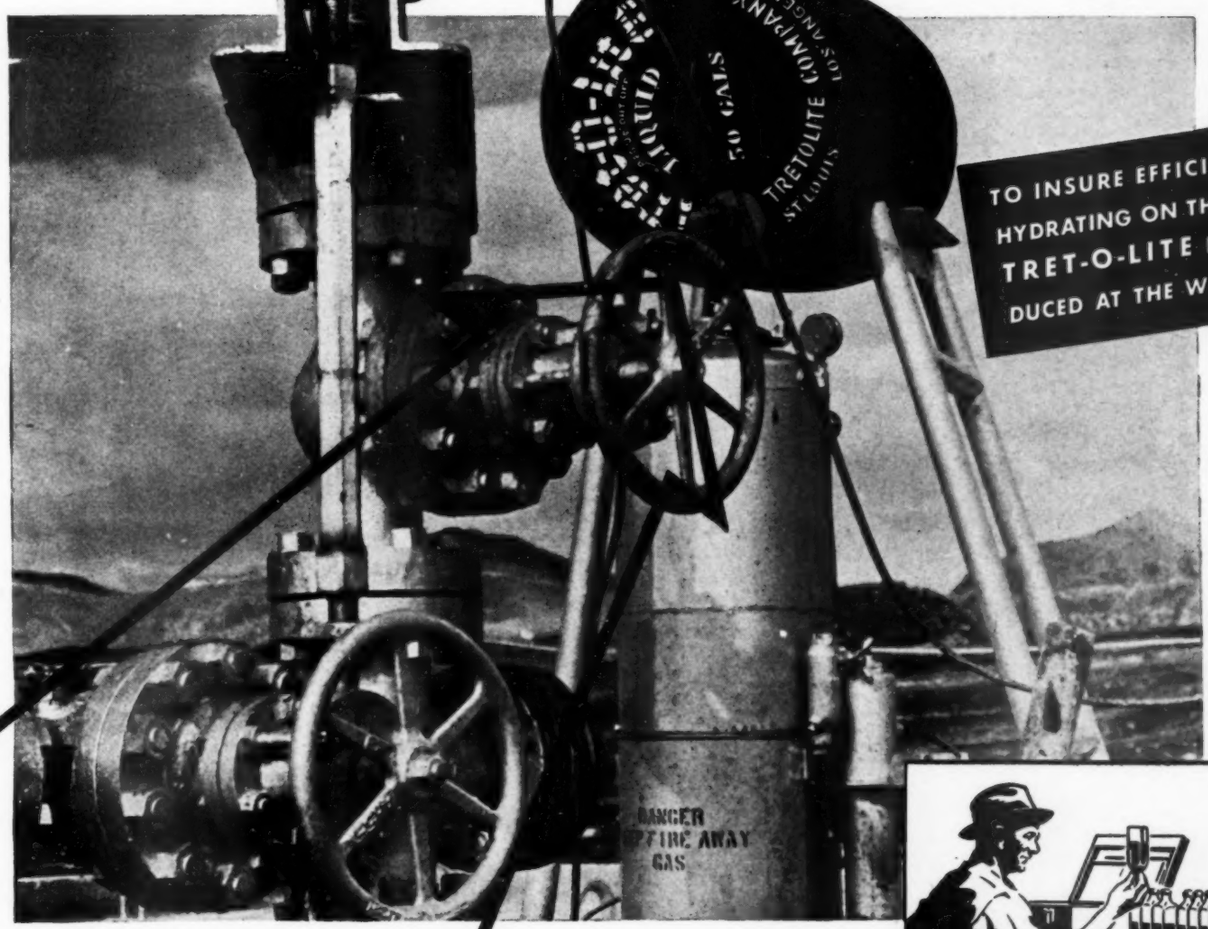
Taking the Mid-Continent-Gulf Coast region as a whole, and assuming that completions in this region during 1942 will be sixty percent of the 1941 completions, all proved forty-acre locations will be drilled by March, 1943, or within a year from now.

Additional acreage will be proved during 1942 by wildcat discoveries, and hence we will not reach the end of our development program by March, 1943, even under the restrictions of Conservation Order M-68. The extension of this time is dependent upon wildcat discoveries. Although there will be wildcat discoveries during 1942, it is difficult to predict the degree of success or failure of this effort. Unless substantial discoveries are made as a result of wildcatting during 1942, the end of drilling in proved areas is immediately in sight, assuming the provisions of Conservation Order M-68 remain unchanged.

The trend of drilling operations, both wildcat and total, for the past three to four months, raises considerable doubt regarding whether the Mid-Continent and Gulf Coast will complete sixty percent as many wells in 1942 as were completed in 1941. In the case of the Eastern area, which includes Illinois, Indiana, Michigan, and Kentucky, unless substantial discoveries are made this year, there will not be enough proved locations to permit drilling sixty percent as many wells in 1942 as in 1941. The same situation applies even to a more pronounced degree to the State of Oklahoma. With the bottleneck in transportation facilities from Texas, New Mexico, South Arkansas, and Louisiana, it is not unlikely that drilling programs will be reduced in that area. This all indicates that less than sixty percent of 1941 pool well completions will be drilled in the Mid-Continent and Gulf Coast in 1942.

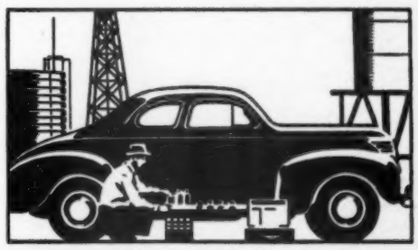
According to data compiled, oil men may visualize the approaching completion of their drilling operations; however, they should bear in mind that increased wildcatting in the critical areas will do much to reverse this trend. The transportation bottleneck is familiar to most of us. The anticipated decline in production in the Central and Eastern Mid-Continent areas will tend to aggravate this transportation problem further, and unless corrected by increased discoveries and increased pool well completions, the situation may well result in more severe rationing, extending perhaps soon even into the Central and Eastern Mid-Continent areas. The need for new reserves in the Eastern and Central Mid-Continent is daily becoming more apparent. This is no time for despair and discouragement. Our job is to take what we have of existing materials, equipment, and facilities and the little that can be spared to us from the manufacture of fighting equipment, and use it where it will do the most good; that is, where the most oil can be obtained and delivered with the greatest efficiency into the war effort with the minimum consumption of steel. That must be our only thought and our sole aim.

ON Guard!



TO INSURE EFFICIENT DEHYDRATING ON THIS WELL, TRET-O-LITE IS INTRODUCED AT THE WELL HEAD.

Tret-O-lite representatives are "on call" to assist you on any emulsion problem. There is no charge for Tret-O-lite Advisory Service.



Tests carried out on the lease provide an accurate means of assuring a proper compound selection.

ALL CRUDES do not respond similarly to a single treating compound or method. Because of this, there is a Tret-O-lite representative in your production area. He has studied the problems in the field and can advise you on the most efficient dehydrating system for the conditions on your lease. This is but one phase of Tret-O-lite Advisory Service . . . there are many, all designed to obtain more efficient and economical dehydration . . . to guard against waste and losses due to inferior procedures.

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Highlights IN OILDOM

New Petroleum Reserves for 1941

The petroleum industry found 1,968,963,000 bbl. of new oil during 1941, or 564,781,000 bbl. more than the 1,404,182,000 bbl. of crude oil produced during the year, the American Petroleum Institute's Committee on Petroleum Reserves has announced.

The net increase raised total known underground reserves of petroleum as of January 1, 1942, to 19,589,296,000 bbl. Total reserves on January 1, 1941, were 19,024,515,000 bbl.

Most of the new oil was added through upward revisions of reserves in fields found prior to 1941, however. Further development of older fields revealed a net addition of 1,538,989,000 bbl. of crude oil that had not been included in previous estimates for those fields because of incomplete development.

Future needs demand that reserves be great enough to allow increases in production without the waste that would follow any prolonged production at greater than the optimum rate. Despite large reserves, the petroleum industry must continue drilling new exploratory wells to find new oil fields. The declining rate of discovery in the last four years, combined with probable increases in demand to supply war needs, makes this drilling program even more imperative now, the Institute states.

The committee's estimate includes only reserves in known and proved fields, and recoverable by present production methods.

Basic data for the report were developed by a number of subcommittees of experienced geologists and petroleum engineers in all important oil-producing areas. The Institute committee signing the report included: J. Edgar Pew, chairman, Sun Oil Company, Philadelphia; R. F. Baker, The Texas Company, New York; Frank R. Clark, The Ohio Oil Company, Tulsa, Oklahoma; Alexander Deussen, consulting geologist, Houston, Texas; G. Clark Gester, Standard Oil Company of California, San Francisco; F. H. Lahee, Sun Oil Company, Dallas, Texas; J. M. Sands, Phillips Petroleum Company, Bartlesville, Oklahoma; Fred Van Covern, American Petroleum Institute, New York; Theron Wasson, The Pure Oil Company, Chicago, and Fred E. Wood, Standard Oil Company (Indiana), Chicago.

Blackout for South Louisiana Fields

Joseph L. McHugh, Louisiana State Conservation Commissioner, has ordered a nightly blackout for 110 oil fields in South Louisiana. The order directs that "all flares in Louisiana oil fields south of latitude 31° north be extinguished between the hours of one hour before sunset and one hour after sunrise." Latitude 31 runs along the northern border of the Florida parishes and cuts through the southern part of Avoyelles, Rapides, and Vernon parishes.

Advocates Relaying Pipe Lines

Jerry Sadler, Texas Railroad Commissioner, has renewed his advocacy of relaying pipe lines as a means of relieving transportation shortage resulting from Axis submarine warfare. He asserts that Texas has 23,841 miles of trunk oil pipe lines, 5000 miles of which could be taken up and relaid to the East.

"Most of the trunk pipe lines are of 10 in. and 12 in. diameter," Sadler said, "and 25 percent of the total could be used to move oil to the East without impairing the present movement from West and North Texas areas to the Gulf Coast.

"The more than 5000 miles of pipe available would be sufficient to lay two lines, which, if put aboveground along railroad rights-of-way, could be completed in three months."

The commissioner added that he believed the best method to relieve the petroleum shortage in the East was to refine crude oil in Texas, which, he said, has ample capacity for the processing, and move the refined products through pipe lines.

Large Petroleum Shipments by Water Reported

One-third of all foreign and domestic waterborne trade of the United States in 1940 was crude petroleum and petroleum products, a report of the Board of Engineers for Rivers and Harbors reveals.

Total shipments of all products by water to and from, and within, the United States, amounted to 607,900,000 tons, of which petroleum accounted for 200,077,000 tons, the report shows. The greatest movement of petroleum was in coastwise shipments, which totaled 114,640,000 tons, or three-fourths of the total 156,929,000 tons of all products. Shipments of petroleum in the other trade classifications were: imports, 13,781,000 tons; exports, 19,835,000 tons; local and intraport, 25,465,000 tons, and inland waterways including Great Lakes, 26,356,000 tons.

Crude petroleum accounted for one-third of the total petroleum movement by water. The shipments of 67,113,000 tons, equivalent approximately to 475,000,000 bbl., would indicate that more than one-third of all the crude petroleum produced in 1940 was transported by water at some point in the movement from the well to the refinery.

Reports of the U. S. Bureau of Mines for 1940 show that U. S. refineries received 320,327,000 bbl. of crude oil by water, and that exports of crude oil, including some pipeline shipments to Canada, added 51,500,000 bbl. The difference between this total of approximately 375,000,000 bbl. and the 475,000,000 bbl. shown by the Board of Engineers' report probably is accounted for by transhipments from water to other transportation methods, differences in classification of products, and duplications.

Total shipments of petroleum products in all trade classifications, as reported by the Board, were: gasoline, 44,344,000 tons; kerosine, 6,788,000 tons; fuel oil, 48,809,000 tons; bunker oil, 15,066,000 tons; lubricating oil and grease, 4,243,000 tons; and other petroleum products, 13,714,000 tons. Sixty-five percent of the crude oil, 55 percent of the gasoline, and 50 percent of the fuel and bunker oil, were shipped in the coastwise trade.

Pipe Lines Modify Purchase Policy

Several pipe lines purchasing crude oil in the West Texas and New Mexico areas have modified their policy of restricted purchases.

The Atlantic Pipe Line Company is now taking 60 percent of allowables in Ward County, Texas, and full allowable from wells in the Henderson field, Winkler County, as well as from the Aloco Pipe Line Company in the Wasson field, and the Richardson Pipe Line Company in the Slaughter field.

Sinclair Prairie Oil Marketing Company, formerly taking 50 percent of allowable in fields it serves, is now taking 75 percent.

Humble Oil and Refining Company has transferred its connections in the Wasson field, West Texas, and some connections in New Mexico to Shell, and in other fields is now taking 100 percent of allowables.

PENBERTHY PRODUCTS

Reflex

DROP FORGED STEEL LIQUID LEVEL GAGE

EMPTY SPACE SHOWS **WHITE** | LIQUID SHOWS **BLACK**

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Transparent

DROP FORGED STEEL LIQUID LEVEL GAGE

USED TO OBSERVE COLOR AND DENSITY OF LIQUIDS UNDER HIGH PRESSURES, AND/OR TEMPERATURES

These gages are made of alloy temperature resisting steel and are of the highest quality throughout. Liquid chamber (both single and multiple section) is made from a solid block of steel to assure perfect alignment and rigidity. Frame has extra heavy beam at each end and glass chamber is accurately machined to contour of glass providing full metal backing for gaskets. Gage valves are drop forged steel with stainless trim.

These gages are available in any length and for various pressures and temperatures. All Penberthy gages conform with A. P. I.—A. S. M. E. requirements.

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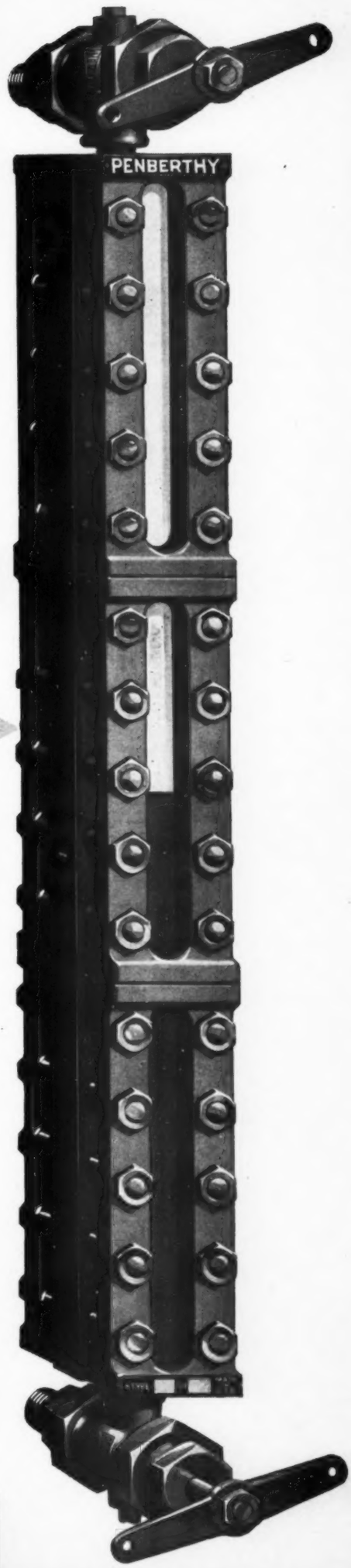
DETROIT, MICHIGAN
Canadian Plant: WINDSOR, ONTARIO



MAJOR *Refining* ACTIVITIES

Percent Refining Capacity Operated

Western Division, 74.0 Percent Central Division, 81.0 Percent Eastern Division, 79.1 Percent

THE Superior Oil Company has let contract to The Fluor Corporation for construction of a cycling plant in the Lake Creek field, Montgomery County, Texas. Capacity of the plant will be approximately 60,000,000 cu. ft. per day. The Lake Creek field was discovered by the company in 1940 and produces from Wilcox oil and gas sands. It is reported that more wells will be drilled to supply the plant with the required volume of gas.

Nearly 25 southwestern refineries and cycling plants, most of which are in the Gulf Coast area, will be shut down because they are not producing essential war products. It is reported that government officials and refiners have agreed in conference that only refineries producing materials vital to the war effort shall be allowed to continue operating.

A plan has been proposed whereby profits of the plants that continue to operate will be pooled and shared on a pro rata basis by the participating companies due to the situation brought about by lack of transportation that has caused refinery stocks to accumulate.

A number of cycling plants in the Corpus Christi area have cut back production and several refineries in the Houston area have closed. Plants to be shut down are small plants in Louisiana and in the Houston, Corpus Christi, and the Beaumont-Port Arthur, Texas, areas.

Construction of a large plant for the manufacture of butadiene, the principal ingredient of synthetic rubber, will begin immediately by Shell Chemical Company, according to J. Oostermeyer, president.

The new plant, which is to be financed by the government as a part of its program to increase production of synthetic rubber, will cost approximately $15,000,000 and will be situated in the West, according to the announcement.

Early experimentation, which developed new uses for synthetic rubber, was based on the butadiene production of a pilot plant at Shell's laboratories. In the early fall of last year, the company began actual production on a large scale at a plant in the Southwest.

The proposed plant, several times larger, will produce many thousand tons of butadiene annually and is expected to be in actual production in mid-year 1943.

Construction work on installation of facilities for the production of 10,000 gal. of *iso*butane per day for the Sunflower Gasoline Corporation in Salem, Illinois, is nearing completion. L. S. Gregory Company of Tulsa, Oklahoma, is constructing the unit.

Consolidated Gasoline Company is installing a Perco gasoline sweetening system at its Martin natural gasoline plant near Eastland, Texas. Present output of the plant is 15,000 gal. of natural gasoline per day.

Equipment to permit increased absorption pressures is being installed by B-W Gasoline Company at its plant near Angleton, Texas, which was moved from Livingston, Texas, last year. The plant is producing 10,000 gal. of natural gasoline and 5000 gal. of liquefied petroleum gases per day.

A new oil absorption natural gasoline plant is being completed at Stinnett, Texas, with operations expected to begin this month. Owned by the Texoma Natural Gas Company, the plant has a capacity of approximately 18,000 gal. per day.

An announcement has been made that construction will begin during the month of May on a butadiene plant at Port Neches, Jefferson County, Texas, to cost approximately $75,000,000. The Neches Butadiene Products Company, formed by the Gulf Oil Corporation, The Texas Company, The Atlantic Refining Company, The Pure Oil Company, and The Magnolia Petroleum Company will build and operate the plant.

From 50,000 to 100,000 tons of butadiene will be produced by the plant each year. Reports state that the land on which the plant will be located has been obtained.

A $27,000,000 expansion program is planned by The Texas Company consisting of plants for the war effort. Much of the money will be used in construction work on the Gulf Coast.

According to the announcement, the construction program calls for a $2,500,000 lubricating oil plant, $7,500,000 alkylation plant for processing 100-octane gasoline, $5,500,000 for a toluene plant, and $4,000,000 for a plant for production of 100-octane gasoline. This expansion will be at Port Arthur, Texas. The company is also considering construction of a butadiene plant.

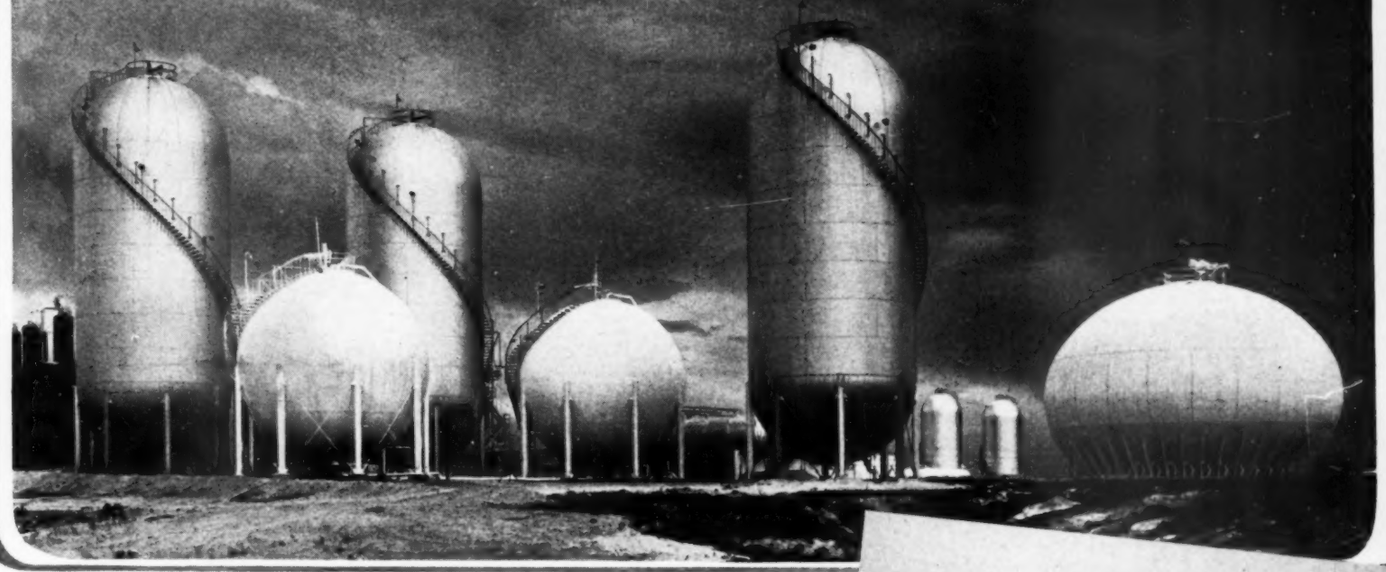
The Continental Oil Company is increasing the capacity of its natural gasoline plant at Ville Platte, Louisiana, 20,000 gal. per day with the addition of oil absorption facilities. Present capacity of the plant is 75,000 gal. of natural gasoline and 60,000 gal. of liquefied petroleum gases.

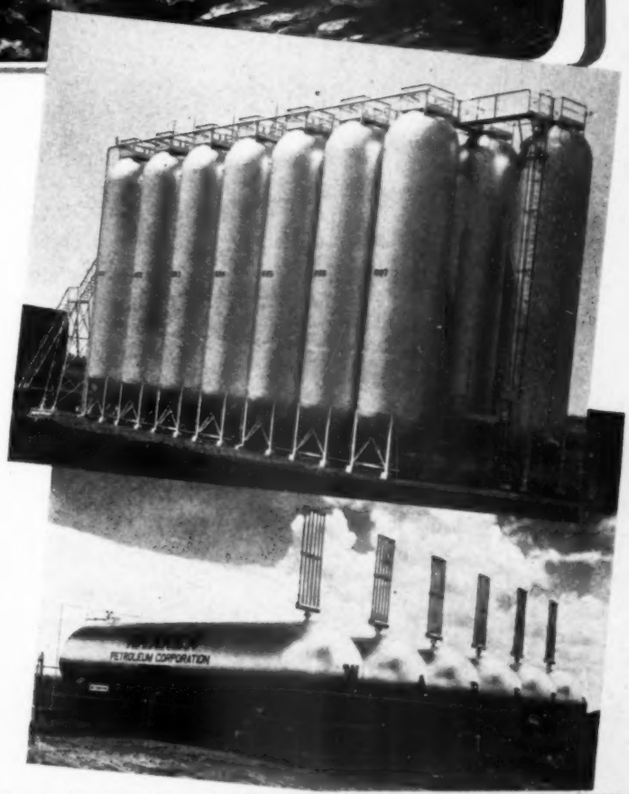
Crude Runs to Stills, Gasoline, Gas and Fuel Oil Stocks
Week Ended March 28, 1942
A.P.I. Figures
(Figures in thousands of bbl. of 42 gal. each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks	Total Gas and Fuel Oil Stocks
East Coast	100.0	461	64.6	16,470	13,687
Appalachian	84.5	161	92.5	3,896	993
Ind., Ill., Ky.	84.9	728	92.9	23,470	6,349
Okla., Kans., Mo.	81.1	325	77.8	10,358	2,566
Inland Texas	65.0	188	70.7	3,850	1,199
Texas Gulf	91.3	893	79.0	21,937	14,207
Louisiana Gulf	94.9	159	90.3	4,502	3,043
No. La. and Ark.	51.5	68	70.1	1,252	361
Rocky Mountain	50.7	93	67.4	2,536	883
California	90.9	591	75.1	17,353	71,613
TOTAL U. S.—B. OF M. BASIS MARCH 28, 1942	86.9	3,667	78.3	(a)105,624	114,801
TOTAL U. S.—B. OF M. BASIS MARCH 21, 1942	86.9	3,599	76.8	106,131	116,415
U. S. B. OF M. BASIS MARCH 29, 1941		3,624		99,086	125,271

(a) Finished 97,345,000 bbl.; unfinished 8,279,000 bbl.

MODERN PRESSURE STORAGE TANKS *for Liquids and Gases*





Hortonspheroids—Hortonspheres—Horizontal and Vertical Bullets . . . all of these tanks are quite dissimilar in appearance, but all have one important feature in common—the ability to protect their volatile contents against evaporation losses. This protection is accomplished by making use of the simple fact that no loss will occur if vapor does not escape from the tank. Thus, units of the types shown here are built to withstand the maximum vapor pressure of the product being stored and are equipped with a relief vent set to open above this pressure. Instead of allowing the air-vapor mixture to escape when the temperature rises, pressure is built up inside the tank. This principle is highly effective in eliminating breathing and boiling losses, and reducing or eliminating filling losses by the recondensing of vapor during filling.

Hortonspheres are built in standard sizes from 1,000 to 15,000 bbl. for 20 to 100 lbs. per sq. in. pressure. Hortonspheroids for storing liquids at 2½ to 35 lbs. pressure are available in standard capacities of 2,500 to 120,000 bbls. Cylindrical tanks, or "bullets" are utilized where smaller sizes are adequate.

Call or write for complete information or quotations.

Top: One 10,000-bbl. Hortonspheroid, two 5,000-bbl. Hortonspheres, and three 12,000-bbl. vertical pressure tanks installed at a Texas refinery.

Center: Fifteen 1,000-bbl. butane tanks installed in Oklahoma. They are 12 ft. in diam., 42 ft. high.

Right: Six 1,000-lb. butane tanks at a marketing terminal. They operate at 80 lbs. pressure.

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MAJOR *Oil Field* ACTIVITIES

A NEW field has been opened by New Penn Development Company well, Harris No. 1, 28-2s-9e, Wayne County, Illinois. The well topped the St. Genevieve zone at 3256 ft. and a drill-stem test from 3275-3311 ft. resulted in a show of 2120 ft. of gas-cut oil and 120 ft. of mud-cut oil when the tool was open one hour. After 13 stands of drill pipe were pulled from the hole, oil shot 75 ft. above the derrick floor. Total depth of the well is 3311 ft. with casing being run to 3270 ft.

Paul Rossi's Mauzy No. 1 in Posey County, Indiana, 8-7s-12w, 4 miles west of the Heusler pool, has opened a new field. Completed in the Aux Vases sand, the well found the Cypress, Paint Creek, and Bethel sands blended without shale breaks. There was an oil showing between 2609-12 ft. and on a core taken from 2612-19 ft. soft saturated sand was recovered. A drill-stem test between 2600-21 ft. with open tool for 35 minutes showed 703 ft. of oil and 275 ft. of muddy oil. Seven-in. casing was set on top of the Aux Vases sand.

Southeastern Nebraska has its first Viola Lime producer in D. D. Bohrer No. 1, of the Power Oil Company, C E½ SW NW, 10-1n-14e, in the Dawson pool of Richardson County. The well is about 12 miles west of Falls City, at whose west edge the first oil well in both Nebraska and the Forest City basin was found. Cement plug was drilled-out on top of the Viola lime at 2922 ft. and the hole filled with 29-gravity oil with some water content. The well was drilled to the lime with rotary tools and completed in the lime with cable tools. The Hunton lime was topped at 2202 ft.

Louisiana has a new oil zone in the Port Barre field, St. Landry Parish, and a new producing area in Jefferson Parish.

In the Port Barre field, William Helis' S. W. Futral No. 2 was completed on the north flank, section 20-6s-5e, with an initial production of 145 bbl. of 39-gravity oil on a 9/32-in. choke through perforations at 6662-80 ft. Tubing pressure was 1050 lb. and casing pressure 600.

New production has been found in the Hackberry area, Jefferson Parish, by The Texas Company with its No. 2-B, LaFourche Basin levee district, section 31-19s-24e. This well was drilled to a total depth of 9887 ft. and flowed 325 bbl. of oil in 24 hours through a 3/16-in. choke with casing perforated at 7470-7500 ft. Gas-oil ratio was 330 to 1 with 1150-lb. pressure on the tubing.

Lockhart Oil Company apparently has discovered a new gas-condensate field in Hidalgo County, South Texas, with Dee Davenport No. 1, Sweeney Estate, south of Donna, Texas. On the first production test from perforations at 6033-38 ft. in sand at 6026-58 ft. an ungauged volume of gas and condensate was recovered through ¼-in. choke. The well has a tubing pressure of 1850 lb. and a casing pressure of 1500 lb. Other production tests were planned from other formations.

Eddy County, New Mexico, has a new discovery in Neil H. Wills' shallow well, Wills No. 1, four miles west of the Getty pool. Total depth is at 906 ft. in lime, and after being shut-in for 12 hours the well bailed 24 bbl. of oil in 24 hours. After tubing and rods were run, the well pumped 26 bbl. of oil during the next 24 hours.

AVERAGE CRUDE OIL PRICES

California	
Kettleman Hills	$1.23-1.29
Playa Del Rey	.80- .87
Coalinga	.73-1.13
Wilmington	.68-1.24
Montana	1.00-1.15
Wyoming	.45-1.15
Colorado	.96-1.20
New Mexico	.70-1.15
Texas	
North Central	.97-1.21
Panhandle	.70-1.12
West Texas	.80-1.27
Gulf Coast	.93-1.48
Darst Creek	1.14
East Texas	.80-1.27
Talco	.79
Kansas	.93-1.25
Oklahoma	.75-1.25
Arkansas	.94-1.36
Louisiana	
Rodessa	.88-1.20
Gulf Coast	.90-1.36
North Louisiana	.98-1.30
Illinois	1.22-1.37
Kentucky	1.32-1.43
Indiana	.85-1.25
Ohio	
Lima	1.17
Michigan	1.24-1.44
Pennsylvania	
Bradford	3.00
Southwest	2.65
Eureka	2.59
Buckeye	2.55
Corning	1.31

DAILY AVERAGE CRUDE OIL PRODUCTION

Data Supplied by A.P.I.

(Figures in bbl. of 42 gal. each)

	[1]O.P.C. Recommendations for March	Week Ended March 28, 1942	Week Ended Feb. 28, 1942	Week Ended March 29, 1941
Oklahoma	405,300	[2]387,350	393,700	408,450
Kansas	245,800	[2]238,900	230,000	211,650
Nebraska	5,100	[2] 4,150	4,450	4,350
Panhandle Texas	.....	89,200	86,700	77,450
North Texas	.....	148,800	148,700	132,250
West Texas	.....	233,200	300,650	241,400
East Central Texas	.....	90,000	91,400	77,900
East Texas	.....	368,200	368,400	445,000
Southwest Texas	.....	195,850	222,900	210,200
Coastal Texas	.....	284,900	296,700	257,100
TOTAL TEXAS	*1,338,600	1,410,150	1,515,450	1,441,300
North Louisiana	.....	81,100	81,500	70,800
Coastal Louisiana	.....	253,800	270,600	235,250
TOTAL LA.	*314,700	334,900	352,100	306,050
Arkansas	71,500	76,750	73,850	70,950
Mississippi	* 53,100	[2] 94,250	90,850	17,750
Illinois	362,500	317,550	334,900	325,200
Indiana	18,000	[2] 19,350	19,150	19,850
Eastern (not incl. Ill. and Ind.)	93,500	96,800	95,550	93,200
Michigan	49,500	45,900	50,850	37,900
Wyoming	80,500	91,000	84,400	74,350
Montana	21,000	21,400	21,600	18,200
Colorado	6,400	5,600	5,550	3,850
New Mexico	*100,200	92,800	120,400	109,000
TOTAL EAST OF CALIF.	3,165,700	3,236,850	3,392,800	3,142,050
California	627,000	583,000	622,850	604,500
TOTAL U. S.	3,792,700	3,819,850	4,015,650	3,746,550

[1]Original March recommendations of O.P.C. were revised downward in states marked thus (*) a total of 204,100 barrels daily as of March 5th to take effect as soon as possible thereafter. The Texas State allowable was revised as indicated by the Railroad Commission through the application of additional shut-down days. No official information on revisions yet available for other states.

[2]Oklahoma, Kansas, Nebraska, Mississippi, Indiana figures are for week ended 7:00 a. m., March 25th.

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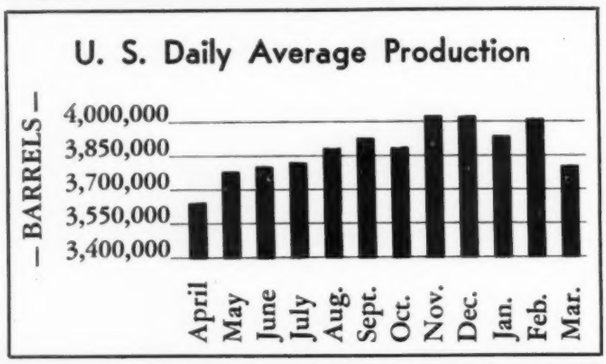
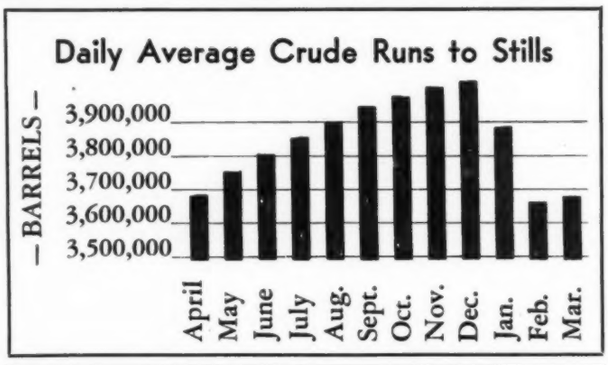
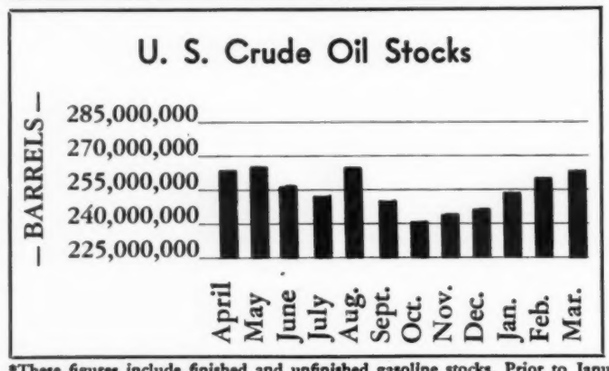
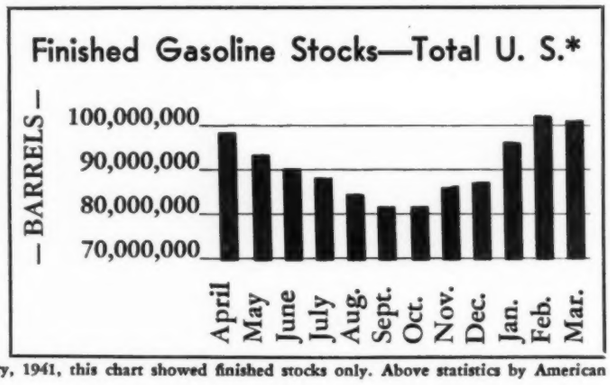
PETROLEUM *Statistics* AND FIELD *Operations*









*These figures include finished and unfinished gasoline stocks. Prior to January, 1941, this chart showed finished stocks only. Above statistics by American Petroleum Institute.

Summarized Operations in Active Fields for March, 1942

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	36	22	6	20	3500-3700	2	40	Rotary
Gaines County	4	3	1	2	4400-5584	2	22-35	Rotary
Hockley County	24	18	4	16	4800-6850	2	20-30	Rotary
Ector County	13	11	3	10	3675-4377	2 or 3	32-36	Rotary
Panhandle	47	41	5	37	1700-3900	2	40	Rot.-Cab.
Nueces County	8	6	2	4	3922-5878	2 or 3	21-54	Rotary
K. M. A. Field	6	4	2	3	3730-3935	2	42-43	Rot.-Cab.
Hawkins Field	12	8	1	6	4495-4912	2	19-29	Rotary
OKLAHOMA								
Okfuskee County	6	4	3	5	2150-4125	2 or 3	38	Rotary
KANSAS								
Russell County	7	6	4	2	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	6	3	3	2	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	4	3	3	3	3290-3518	2	39-42	Rot.-Cab.
ILLINOIS								
Central Illinois	184	63	98	104	1425-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	14	12	6	5	3150-4030	2	30-34	Rot.-Cab.
CALIFORNIA								
Kern County	18	15	5	6	1840-11,450	3 or 4	14-30	Rotary
Wilmington	6	5	4	2	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for March, 1942

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1941 (In Barrels)
	February	March	February	March	February	March	February	March	February	March	
Arkansas	8	18	5	14	6	3	7	3	5	3	29,263,000
California	72	50	63	36	78	50	67	40	43	21	230,271,000
Colorado	2	....	....	....	1	....	1	....	1	....	1,792,000
Illinois	184	98	138	63	175	79	198	98	143	104	131,272,000
Indiana	37	25	22	13	39	26	17	8	32	16	6,998,000
Kansas	121	72	82	43	142	70	27	14	135	88	82,733,000
Kentucky	19	....	7	....	18	....	5	....	12	....	4,790,000
Louisiana	91	84	33	53	94	46	40	22	96	41	116,038,000
Michigan	61	28	35	15	58	34	21	11	49	25	16,312,000
Mississippi	7	9	4	4	....	....	....	....	....	....	15,528,000
Montana	12	7	11	5	7	3	3	1	9	4	7,440,000
Nebraska	1	....	1	....	....	....	....	....	....	....	1,785,000
New Mexico	30	36	23	28	26	13	14	6	25	15	39,109,000
New York	102	88*	102	88*	....	....	....	....	....	....	5,180,000
Ohio	136	53	97	42	....	....	....	....	....	....	3,342,000
Oklahoma	143	94	107	57	170	81	33	15	114	73	154,817,000
Pennsylvania	169	248	165	243	....	....	....	....	....	....	16,700,000
Texas	558	435	412	311	630	495	718	308	712	310	501,745,000
West Virginia	79	48	68	41	68	40	30	16	47	25	3,418,000
Wyoming	6	6	4	4	4	3	4	2	3	1	29,952,000
Total	1838	1399	1379	1060	1516	943	1185	544	1426	726	1,398,485,000

*Includes water-intake and pressure wells.

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Put your wells on the Nixon Gas-Lift. One of our gas-lift engineers will give you complete details and data regarding their efficiency and economy. Write your nearest Wilson Supply Company store or sales office.

The following patents have been issued on the Nixon Surface Control Gas-Lift System: 1,735,025; 2,132,081; 2,136,457; 2,153,770; 2,164,469; 2,171,812; 2,171,478; 2,171,479; 2,171,480; Re 21,199; 2,202,462; 2,204,817; 2,217,072; 2,245,002; 2,245,003; 2,245,004; 2,245,005; 2,245,006; 2,245,007; 2,245,008; 2,245,009; 2,245,010. Other patents pending.

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MAJOR *Pipe Line* ACTIVITIES

REALIZING the seriousness of the petroleum transportation situation, and its attendant possible slowing up of many activities in plants operating on war contracts, W. R. Boyd, Jr., chairman of the Petroleum Industry War Council, has announced the selection of a special management committee.

The committee was selected after an engineering subcommittee had reported to the Council its findings and recommendations on the East Coast supply problem. The principal findings of the subcommittee was the possibility of "robbing" existing lines not essential to the war effort, and to relay them where they will be helpful in alleviating the current shortage on the Atlantic Coast. It is suggested that the industry stretch this program of reinstalling lines so far as possible, but it is apparent that after all possibilities in this direction have been exhausted, the relocated lines will prove inadequate to supply war and related needs.

The subcommittee explored every existing facility before considering the construction of new lines, but a valuation of all factors indicates the necessity of new lines if essential military and civilian needs are to be supplied.

J. S. Knowlson, Director of Industry Operations, and R. Otis McClintock, Petroleum Liaison Officer, both of the War Production Board, were present at the meeting. The Office of Production Management, forerunner of the War Production Board, had previously rejected the recommendation of the Office of Petroleum Coördinator for steel for the construction of a large pipe line to serve the East Coast.

The impending shortage is definitely linked with two important phases of the war effort—the production on one hand of toluene, 100-octane gasoline, fuel oil, and numerous other products, including those for synthetic rubber; and on the other, the supplying of petroleum products to ammunition factories on the Atlantic Seaboard and to shipyards, arsenals, precision instrument plants, and many other war activities.

Some time ago, an engineering subcommittee representing the transportation committees of Districts One, Two and Three was appointed to make a detailed study, and as a result of the findings of this subcommittee, the Council's special management committee was named. W. Alton Jones, president, Cities Service Company, New York City, is chairman.

The engineering subcommittee is to continue its work with W. R. Finney, Standard Oil Company (New Jersey), New York City, as chairman.

Normally about 95 percent of the East Coast's petroleum demand is delivered by tankers, but as a result of tanker diversion, operating difficulties, and sinkings, only a small part of this demand is now being moved in this manner.

Every effort is being made by the oil industry to obtain maximum utilization of alternate means of transportation. The emergency created has been partially relieved by increased tank car movement. Greater use is being made of inland waterways, and tank truck transports have been used to good advantage on the shorter hauls. Despite these accomplishments, and facing the decreased tanker tonnage that will be available to supply the East Coast, pipe lines offer the best solution to avert a shortage.

The Oklahoma Natural Gas Company is planning construction of 96 miles of 12-in. natural gas pipe line to extend from the Chickasha field to Stroud, Oklahoma. Bids have been received by the company for the job.

Construction of a major pipe line from East Texas to a point in Illinois, possibly Salem, where it would connect with other lines and rail transportation, has been recommended by the special transportation committee of the Petroleum War Industry Council. This report was prepared under the direction of H. C. Wiess, president of the Humble Oil and Refining Company, Houston, Texas, a member of the committee. Capacity of the recommended line would be 300,000 bbl. per day. This project is among 10 specific proposals by the committee, which would cost approximately $200,000,000 and provide a solution of the present transportation difficulties. The line would not require as much steel and equipment as the defense pipe line for which priorities have been refused by the War Production Board. Although prospects for procuring the steel and equipment for the line appear doubtful, the committee is understood to have declared that the line is the only sure solution of the problem.

Purchase of 50 miles of trunk and gathering lines, of 8-in., 6-in., and 4-in. pipe, in the East Texas field has been made by The Texas Pipe Line Company from The Frontenac Pipe Line Company, Tyler, Texas, according to a confirmation by John Warren, vice-president and general manager of the Frontenac company. Also included in the deal was 30,000 bbl. of storage.

Work on the pipe-line program of Panhandle Eastern Pipe Line Company in Michigan is progressing, according to latest reports. More than 25 miles of the 75 miles of welded pipe have been laid. Construction is progressing rapidly on the section of line, 45 miles in length, near Galesburg, Illinois, which was contracted for by I. C. Little. Oil States Construction Company has the contract for the Michigan section of the line.

Construction on the Phillips Petroleum Company line for supplying operations at Borger, Texas, will begin early in May at which time the first pipe deliveries will be made. About 237 miles of the line will be of 8-in. pipe and 54 miles of 6-in. Work on right-of-way and other preliminaries are underway at present.

The Kansas-Nebraska Natural Gas Company of Phillipsburg, Kansas, has purchased the property of the Ak-Sar-Ben Natural Gas Company in Nebraska, according to an announcement by Reece McGee, president of the latter company. No information regarding the purchase price was given.

The Kansas-Nebraska Natural Gas Company now owns 1100 miles of pipe line serving 25 communities in Kansas and 65 in Nebraska. With gas supplied from the Hugoton field, Kansas, the company's territory extends from Ogallala to York and Exeter. The Ak-Sar-Ben Company owns lines and distribution systems in the Republican Valley area from Minden to McCook.

An 8-in. gas line will be constructed by the Pan American Gas Company from the Chocolate Bayou field in Brazoria County, Texas, to Texas City, Texas, it has been announced by E. R. Turner, vice-president. Construction of the line is made necessary by an increased demand caused by expanding war industries in Texas City. Contract for the line was let to Williams Brothers Construction Company.

THE Petroleum Engineer

APRIL, 1942

Cement Slurry to Fit the Job

Exclusive

☆ Selection of cement for specific purposes and methods employed in its placement are of vital importance

by Wallace A. Sawdon

Pacific Coast and Foreign Editor

VALUABLE data have been obtained during the last year or two on the use of cement in oil wells. These data, covering the selection of cement for particular purposes and the methods employed in its placement, have aided materially in the successful cementing of casing strings and in repair and recompletion operations. Although the results of laboratory tests and of actual field work have appeared in the literature a reference to the more recent of these may remind the operator of certain factors that may warrant greater attention in cementing operations. Successful first jobs are not only better but also more economical than recement jobs; and at this time when material, labor, and time must be conserved, any efforts that result in savings in any of those categories will be well worth while.

A greater amount of recompletion and repair work can be expected in the coming months and cement will play an important part in these operations. Greater attention has probably been paid to the selection of the cement and to the mixing and placement of the slurry in casing jobs than in recompletion and repair work; yet many reconstruction jobs present problems more difficult of solution than the initial cementing of a string of pipe. It is only logical, therefore, that due consideration should be given to the character and behavior of cement in performing such jobs.

Adequate surface and subsurface equipment has been developed for the performance of the many types of cement jobs now necessary during drilling and completion of oil wells. Cementing companies have developed techniques that have insured very high efficiency in the handling of the cement at the surface, providing speed and consistency of mix at whatever pumping pressure may be necessary. The planning of the job, the proper preparation of the hole, the amount of cement to use, the selection of the kind of cement, and the determination of the water-cement ratio are, however, dependent on down-hole conditions that are known only to the operator.

By preparation of the hole is meant not only putting the hole in the best condition possible to take the cement, but also providing the casing string with equipment that will help insure a successful job when such equipment is necessary. This applies mainly to casing jobs, as the condition of the hole and the equipment in place are usually fixed quantities when recompletion or repair work is to be done. The selection of the casing point is important but the most desirable casing point cannot always be used because of existing conditions.

It is obvious that the casing should be completely encased by the cement and that this encasement should be as nearly uniform as possible. In some instances it is advisable to enlarge the hole at and for some distance above the shoe to provide a suitable plug of cement. In other cases some device for centralizing the casing in the hole should be employed, particularly when the hole is known to be deviating at or just above the casing point.

When cement is placed against porous formations the mud cake formed on those formations during drilling will interfere with the bond of the cement with the formation and will sometimes start channeling. A study of channeling, the effects of mud cake on the bond, and the relative value of various mechanical devices and chemical means for the removal of mud cakes was made about two years ago by one of the major oil companies in California.[1] These studies indicated that the mud cake formed on formations having appreciable permeability will remain between the set cement and the formation unless specific means are employed to effect its removal; and that whereas the movement of the casing and circulation of water may reduce the thickness of the mud cake slightly they will not remove it completely.

In estimating the quantity of cement to use for a casing job it has been the custom to assume that the hole diameter will closely approximate that of the gauge of the bit used to drill

[1] "Oil Well Cementing Factors Influencing Bond Between Cement and Formation," by P. H. Jones and Denis Berdine, Spring Meeting of Pacific Coast District, A.P.I., Los Angeles, March 19, 1940.

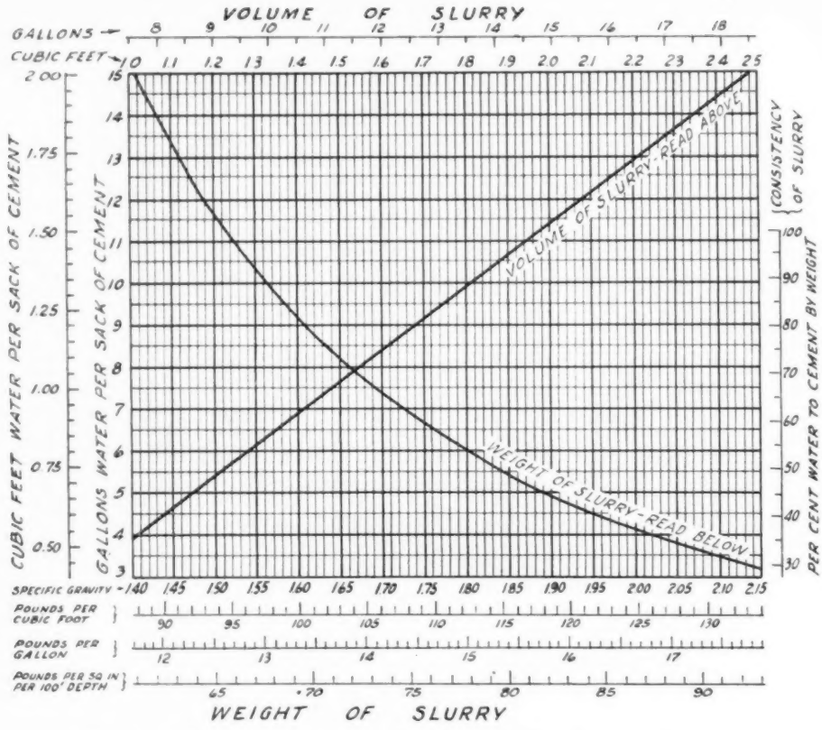

VOLUME OF SLURRY
GALLONS
CUBIC FEET
CUBIC FEET WATER PER SACK OF CEMENT
GALLONS WATER PER SACK OF CEMENT
VOLUME OF SLURRY-READ ABOVE
WEIGHT OF SLURRY-READ BELOW
CONSISTENCY OF SLURRY
PER CENT WATER TO CEMENT BY WEIGHT
SPECIFIC GRAVITY
POUNDS PER CUBIC FOOT
POUNDS PER GALLON
POUNDS PER SQ IN PER 100' DEPTH
WEIGHT OF SLURRY

Fig. 1. Volume and weight of slurries of different consistencies shown graphically

the hole. Recently calipers have been developed to measure the actual size of the hole. Caliper logging during the past year has disclosed that the hole is generally much larger than the gauge of the bit. Moreover, it has been discovered that, contrary to expectations, the hole is usually larger in shale than it is in sand. In practically all wells where the calipers have been run to measure the actual size of the hole prior to running the casing and cementing, the volume of slurry estimated before taking a caliper log has been found to have been inadequate to fill the space behind the casing to the desired height.

When several producing formations are penetrated during drilling and it is planned to cement casing through all the zones and test them individually, the importance of carrying the cement to a point above the top zone is evident. In many cases the presence of salt water and mud found when the upper formations were perforated has probably been due to the use of an insufficient amount of cement slurry to reach above the top zone because the diameter of the hole throughout the distance cemented was appreciably larger than the gauge of the bit.

Assurance that the quantity of slurry used is sufficient is important in any job where the cement must reach a predetermined point. The top of the cement behind casing can usually be determined by means of a temperature survey made after the cementing job is completed. Such a survey, however, does not put more cement behind the pipe although its value in determining the top of the cement is obvious.

Selection of Cement and Consistency of Slurry

Cement manufacturers have developed several grades of cement to meet the different conditions encountered in the cementing of oil wells and these various cements have certain chemical and physical characteristics that are covered by the manufacturer's specifications. High early strength is desirable for all cements used in oil-well cementing and in the majority of cases the cements should be sulphate resistant. Of great importance is the thickening rate of the cement, which corresponds to some extent to the setting time specified for the product. The faster setting cements are the construction types of Portland cement and the slower setting grades are those listed as oil-well cements. Most tests of chemical and physical properties are made by the manufacturer[2] but there are some particular tests that have been developed within the oil industry itself to provide certain other necessary information.[3] Most important of these is the thickening time test. The actual rate of thickening varies to some extent with different cements of the same setting time grade and is greatly affected by water-cement ratio, temperature, and pressure.

No general discussion of water-cement ratio need be given here, as it is universally recognized that increasing the water in the mix lightens the slurry, increases the volume, and weakens the cement. The volume and weight of slurries of different consistencies are shown graphically in Fig. 1. It must be remembered, however, that the water-cement ratio is the flexible factor that permits the making of a slurry most adaptable to a particular job after the kind of cement that most nearly meets existing conditions has been selected.

Cement manufacturers have been constantly improving cement for oil field use and are now providing products highly suited to this service without sacrificing other desirable characteristics. Among the most important properties is low initial viscosity with low water-cement ratio; that is, the cement slurry will be pumpable for a longer time than one of a heavier mix. The most desirable cement is not always available, particularly in foreign countries where operators are far from the source of supply, and the water-cement ratio must then serve to provide a slurry that will stay mobile for the necessary displacement time. Under such conditions retarding agents may become necessary, for the quantity of water used must not be great enough to weaken the cement too much. With the cements now available in the fields of the United States, however, neither retarders nor accelerators should have to be added to the cement after it has been delivered by the manufacturer if the proper kind has been specified.

Thickening time tests are generally made at atmospheric pressure with either the thickening-time machine[4] developed in California or the cement consistometer[4] widely used in the Mid-Continent. These take into consideration the effect of temperature on the thickening time. Although pressure quite evidently has beneficial effects on the density of the cement when it sets, it also decreases the thickening time of the slurry. Equipment for testing slurry for thickening time under pressure as well as temperature has been employed by one of the oil companies in the Mid-Continent and some val-

[2]"Specifications for Oil Well Cements," by Eugene L. Davis, Spring Meeting of Pacific Coast District, A.P.I., Los Angeles, April 19, 1938.

[3]"Cement for Oil Wells: Status of Testing Methods and Summary of Properties," by W. W. Robinson, Mid-Year Meeting, A.P.I., New Orleans, May 17, 1939.

[4]Described in "Determining Suitability of Cement for Oil Well Cementing," by John E. Weiler, *The Petroleum Engineer*, September, 1938, and also in the paper by W. W. Robinson referred to previously.

uable data have been reported on the results obtained with this equipment.[5,6]

The time necessary to displace a predetermined volume of slurry at a given depth through certain size pipe with the pumping equipment to be used for the operation is readily computed. During this time the slurry must remain in a pumpable state and the kind of cement and the water-cement ratio should be selected that will assure that pumpability being maintained. In most cases a time factor of safety is added to provide for emergencies. Though it might seem that the best cement to use would be one that would remain pumpable for a long time and set slowly, it is not only a natural desire to have the cement set as quickly as possible after it is in place but it is usually necessary if the job is to be successful. This is particularly true if there is gas or water present under pressure that may cause agitation. Moreover, frequently migration of water from one level to another occurs, no indication of which can be observed at the surface. Then there is always that desirable quality of high early strength.

All tests made on cement slurry indicate that the strength of the set cement is lowered by agitation that occurs after the slurry begins to set. Of greater importance to guard against than reduced strength in most cases are greater permeability and poor bond of the set cement resulting from probable granulation and non-uniformity of the mass and caused by moving the slurry after it has begun to set rapidly.

When using the thickening time tests to determine the cement and mix to use for necessary displacement time, an arbitrary limit has usually been employed. This has been an estimated limit of pumpability of the slurry. It is now thought by some engineers that this limit is too high and that the cement should be in place by the time rapid setting begins, which is sometimes appreciably earlier than the arbitrarily established limit and will vary for different cements. As an example, the curves given in Fig. 2 show this for a cement slurry tested with the high-pressure consistometer,[5] the cement being an oil-well cement, the cement ratio 40 percent by weight, the temperature 140°F., and the pressure 5000 lb. per sq. in. The "poises" indicating the consistency is a convenient unit of consistency and 40 poises is the estimated limit of pumpability generally used, corresponding closely with the 40-ounce pull of the thickening-time machine and with the reading of 4 on the consistometer used for testing with different temperatures at atmospheric pressure.

[5]"Effects of Temperature and Pressure on Rheological Properties of Cement Slurries," by R. Floyd Farris, *A.I.M.E. Petroleum Development and Technology*, Vol. 142, 1941.

[6]"A Practical Evaluation of Cements for Oil Wells," by R. Floyd Farris, presented at Annual Meeting, A.P.I., San Francisco, November 6, 1941.

The series "Refinery Practice for the Operating Man" has been omitted from this issue of *The Petroleum Engineer*, but will be resumed in the May number, beginning the study of lubricating oil manufacture.

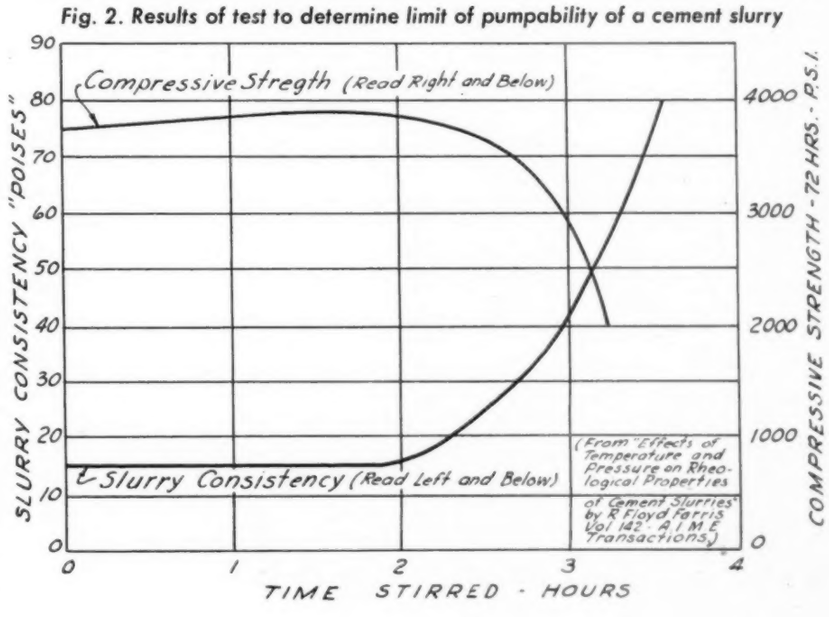
It is accepted that high temperatures accelerate setting time and initial setting of the cement. Due allowance must naturally be made for temperatures above those used in making a thickening time test when determining the kind of cement and mix of slurry to be placed in a high temperature well. It is very doubtful, however, whether the slurry ever attains a temperature as high as the well temperature to which it is subjected during its placement and in general it will never exceed the return circulation fluid temperature. The heat of hydration that is caused by the setting of the cement will usually be greater than any heat given to the cement by well temperature, and as this heat is developed after the cement begins to set it has no effect on the slurry before all pumpability is lost.

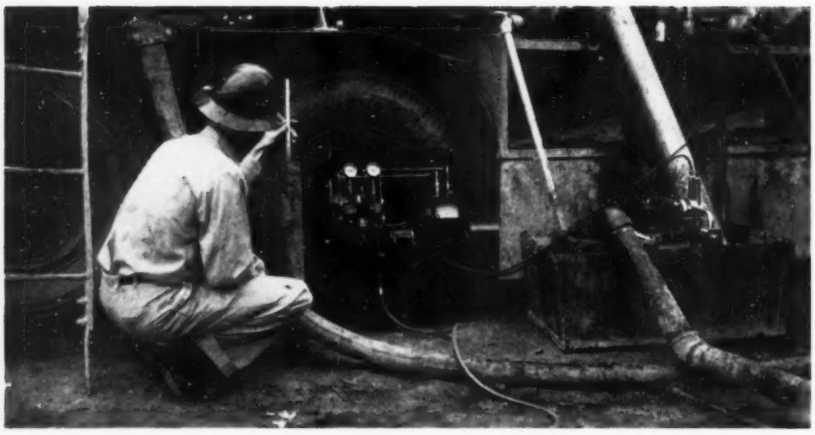
The effect of pressure on cement slurry has probably not been given due consideration when high pressures are necessary to displace the cement. The effect of pressure on the cement is probably beneficial when its placement has been completed before the slurry loses its mobility, as the resulting set cement will be a denser mass when placed under pressure. This is particularly true when the water-cement ratio is comparatively high. High pressures applied to the slurry during displacement, however, have been found by tests to accelerate greatly the thickening and setting time and when not provided for may so increase the thickening rate as to render the slurry unpumpable before it is in place.

Most of the cements tested with the high-pressure consistometer at 5000 lb. per sq. in. and 180°F. were found to set too rapidly to permit proper placement in a deep well. So high a pressure is seldom necessary and the slurry being placed in a well with bottom-hole temperatures even higher than 180°F. will probably not get that hot. When such conditions must be met, cement manufacturers will undoubtedly provide an adequate product if they are given the desired specifications. No set rule can be established for percentage of thickening time decreased by pressure because different kinds of cements will react differently. Moreover, the temperature will influence the effect of pressure as will also the water-cement ratio. Considering all classes of cement now being used in oil wells and various temperatures up to 180°F., the decrease in thickening time due to a pressure of 5000 lb. per sq. in. ranges between 25 and 60 percent. Lower pressures, of course, have less effect. A better realization of the effect of pressure on thickening time is probably desirable.

The gelling action of some cements that may cause a flash set, particularly when displacing slowly through large-diameter casing, is also influenced by pressure. This action is less likely to occur when the slurry is being placed

Fig. 2. Results of test to determine limit of pumpability of a cement slurry





(Courtesy Halliburton Oil Well Cementing Company)

Fig. 3. A company engineer checking his hydrometer against a constant reading slurry meter

through tubing or drill pipe for repair work, as the inside diameter of the cementing string is small and the slurry is usually pumped down rapidly.

Uniformity of mix should be maintained on all types of jobs and when for any reason more than one kind of cement is used in performing a job, or if the water-cement ratio is changed, the mixing of each part of the slurry should be kept uniform.

When prepared bentonite is added to the cement for any purpose it must be remembered that the bentonite requires water for its own hydration in addition to that necessary for mixing with the cement and that the amount of bentonite used will govern the amount of additional water.

Squeeze Cementing

In recent years "squeeze cementing" has been used for numerous types of repair and recompletion jobs and for recementing operations. It has also been employed for original completions, particularly when a string of casing has been cemented through a number of prospective strata and the various strata gun-perforated successively to test for production, the unproductive formations being squeezed off.

Broadly, the term squeeze cementing is applied to the placement of slurry under pressure without benefit of circulation at the place where the cement is to be deposited. The amount of cement to be squeezed is usually very small but in some cases a comparatively large volume of slurry can be put away. When recementing after a failure or when sealing-off formations containing water channels or crevices the slurry is probably forced under pressure into the channels or cracks in the cement or into the water channels or other openings in the formations. When squeezing-off water or gas sands, without channels or other openings accessible to the slurry, the action of the cement is quite different whether the slurry is placed in open hole, up around the shoe and behind the pipe, or through gun perforations.

So far as is now known, the effectiveness of squeeze cementing off water- or gas-bearing sands depends on the permeability of the formations and the ability of this permeability to provide for the formation of a cement filter cake on the face of the sand. Numerous tests made by various companies indicate that cement applied to water or gas sands commonly found in oil wells does not penetrate beyond the face of the sand no matter what pressure is applied. These sands, under formation pressure, carry water or gas to the bore of the well and when a pressure greater than the formation pressure is applied in the well, water or gas will pass from the bore into the formation. While building up this differential pressure during squeeze-cementing operations, some of the water contained in the slurry is squeezed out and forced into the formation. This loss of water causes a cement filter cake to form on the face of the sand.

The filter cake formed of cement solids seals off the flow of water or gas into the hole. Although its formation is similar to that of a mud filter cake built on the walls of a hole while drilling, the cement cake becomes a permanent seal as soon as the cement sets. The bond of the cement placed under pressure on a porous formation is probably better than that formed on impervious formations or even on porous strata when the slurry is applied without pressure. Examination of sands after tests have also indicated that in the more permeable formations there may occur some cementation of the grains for a distance as far as ½ in. from the face. Such cementation is believed to be due to the deposition of silicates or hydroxides from the water squeezed from the slurry, as a solution of a certain amount of cement particles takes place when the cement is mixed with water.

The density of the cement forming the filter cake is favorably influenced by the pressure and is relatively greater as pressure is increased. The water-cement ratio affects the density and a thin slurry will form a thicker, but less dense, filter cake, the filter cake being considered that part of the cement body that has lost water into the formation. Under certain conditions and with sufficient pressure the entire cement body lying opposite the sand may be a filter cake.

The effective cement when squeezing-off a porous formation is probably only that which forms a filter cake on the sand. In many cases, however, an amount of cement much greater than that required for the formation of a filter cake is put away. Where this slurry goes is not definitely known. In some wells it may go into crevices; in others it may, under great pressure, raise or depress a more or less compressible formation above or below and make a local crevice along a bedding plane that will take the slurry. When the squeeze is made behind pipe the possibilities of slurry dissipation by high pressures are probably considerable under certain conditions.

Due consideration must be taken of down-hole conditions and the proper cement and water-cement ratio determined to allow for displacement time when squeeze cementing. The higher squeeze pressures, however, are not applied until the cement is in place and no actual movement of the slurry then occurs. Mobility of the slurry therefore does not have to be considered beyond this point and the effect of pressure on hastening the thickening time and initial set and in reducing the water content is thus advantageous. High temperature will, in most cases, have negligible effect until after the slurry is in place and will also assist in accelerating the set after placement.

In performing many squeeze jobs an excess of cement often must be pumped down the tubing or drill pipe and this excess should be circulated out of the well before it sets in the pipe. The effect of temperature and pressure on accelerating the thickening time must, therefore, be considered when there is a possibility that all the slurry will not be put away.

☆☆☆

Big Decline in Oil Reserves Imminent

Exclusive

☆ How to reverse unfavorable trend of declining oil reserves is urgent problem facing the industry

by Prentiss T. Moore

THE last factor now has been added for estimating that the United States petroleum supply is over its peak for this era at least; also that the reserve supply will shrink severely during the war and for awhile afterwards; and if war should be long, might shrink so severely as to imperil best war efforts. Policies of the war boards at Washington will have effect on the last point, either good or bad, according to the wisdom of those policies.

Oil statisticians of future years very likely will look back to the great drilling slump in 1942 as a good marker for the end of the era of abundance of oil that began in 1927. At any rate, an era of superabundance of oil at cheap prices is almost certainly about to end.

The necessity of rationing supplies for oil-well drilling and equipment has tripped the balance.

All depends on the oil drill.

"We must bear in mind the fundamental difference between the nature of the problem of stimulating the production of crude oil and that of increasing the output of any other industry . . . The oil business is unique because increased production can only be secured (or maintained) through drilling new wells."—*(Alfred Cotton Bedford, in address to the U. S. Chamber of Commerce at Atlantic City, September, 1917.)*

It cannot be hoped that the limitation put on drilling because of scarcity of materials will run only through 1942. Probabilities are more likely that it will continue "for the duration." No one knows how long the war will last. All preparations of the United States and England, according to what has been published, take into consideration the possibility of warfare even in 1944. The longer the war lasts, the greater is likely to be its demand for all materials that can possibly be spared. Severe rationing of drilling materials might be a necessary policy of the War Production Board until victory is won.

The longer that new drilling is curtailed, the greater the probability of an extraordinary shrinkage in the underground inventories, and an even more extraordinary shrinkage in the percentage of quickly available oil in the reserves.

The tide had already turned against maintenance of underground inventories of recoverable oil at the present level of 19 or 20 billion barrels, owing to marked falling-off in discovery and dwindling of high-yield drilling territory. Drilling was already weakening some because of rise in costs of certain materials and certain forms of labor; and since this country entered war, is feeling some of that repressive influence that war has on all businesses requiring much initiative. The rationing of drilling materials to 60 percent of normal requirements could have but one result, to reduce drilling by 40 percent at least. Features of the plan for apportioning the limited supplies present complications that are already causing almost complete cessation of drilling in many localities, and leaves it uncertain whether enough additional drilling can be done in other localities to prevent more than a 40 percent decline in new well completions. Then the interruption of the regular flow of crude oil from fields to refineries, in order to adjust the supply to war's special needs or because of other reasons, holds possible complications that might in the end force diversion of some drilling supplies from high-yield territories to low-yield areas, and this would reduce the average yield of new holes and curtail the general supply by that much. How heavy the draft that war will put on the United States oil supply is not certain. Washington estimates are that it will be very heavy, when the war effort is fully coördinated. These estimates exclude the possibility that before the enemy is beaten the United Nations may lose other important foreign supplies now available; this would throw a still heavier burden on United States fields.

Thus all factors that influence the maintenance of the United States underground inventory of recoverable oil are now unfavorable.

PRENTISS T. MOORE

wrote an oil news column for the *Muskogee Phoenix* in 1913—In 1915, went to Tulsa, Oklahoma, as staff correspondent of the *Fuel Oil Journal* of Houston, Texas—Continued in charge of Mid-Continent section of that journal after it moved to New York in 1917 as the *Oil Trade Journal*—In 1919, was in Dallas for a year under contract with the Chamber of Commerce "to put Dallas in the oil news datelines"—From 1919 onward, was an occasional contributor to New York dailies, especially the *Wall Street Journal*, of articles on general aspects of the oil business—From 1920 until into the middle 30's also acted as private correspondent for eastern banking and stock-and-bond houses, as a specialist in the matter of the United States crude oil supply—For the last 14 months has been gathering data for a history of the petroleum industry since the Dissolution Decree.

Adequate Prices Necessary

Left are two possibilities that might prevent petroleum supply from declining too sharply. Early discovery of extraordinary new oil fields is one. Wise government of the oil business by the war boards at Washington is the other.

That war board closest to the petroleum industry, the Office of Petroleum Coördinator, has shown, in its analyses of the oil supply, a keen realization of its unfavorable status. Its peculiar plan of rationing drilling materials has played havoc with drilling statistics; but the rationing had to be done; and the plan may be shrewdly calculated to obtain certain results of which nothing has been said; that is, of forcing drilling into potential high-yield territory where wells spaced off a thousand feet or more from other oil wells can be expected to produce more oil per well than the average of ordinary drilling. The Petroleum Coördinator's office is showing much elasticity and adaptability, modifying or changing policies as the situation demands.

The influence of the War Production Board is indirect, through its control of materials, but by diminishing or increasing its allotment of materials for oil drilling, it could do more or less to change the trend of available oil supply,

when or if the materials situation compels or allows.

Of importance toward guaranteeing that the drilling branch of the industry take full advantage of the limited amount of drilling supplies are the policies of the Office of Price Administration; right now these policies are distinctly unfavorable. It probably could do more immediately to help hold up the oil supply than either of the other two boards. Current prices of crude oil have been on a subnormal basis for years, and are insufficient to allow drilling operations to continue in many areas under the restrictions and limitations made necessary by scarcity of materials, especially as many operators are now going in the red because of war's disruption of regular flow of oil from many fields. Fairer oil prices would have constructive effect on the supply trend, and might be necessary if even the limited drilling supplies are all to be used

For instance, it is not certain that the liberal allowance of the Petroleum Coördinator's office for the highly important continuance of discovery work in 1942 will be used up by wildcatters unless there is some stronger stimulation for discovery effort. Those large and small companies with reserves of capital may be counted on to do their utmost to push discovery, as a patriotic duty. But such a large percentage of wildcatting is done by drillers with little or even no capital that many of them are now necessarily sheering away from new ventures. If it is deemed important that heavy discovery work go on, the stimulation should be given without delay. The great drilling machine is a ponderous mass, and when it begins to lose momentum it is extremely difficult to get it back into fast movement again. All past history of the business shows that only the stimulation of better prices will stir wildcatting or general drilling into new vigor when once it has quieted down. Even with much better prices and very heavy drilling, past experience shows that once wildcatting has developed an unfavorable trend it is a long and hard task to regain enough high-yield territory for normal drilling to maintain supply.

As more adequate oil prices, prices more commensurate with the cost of finding oil and recovering it, would materially aid the hazardous and costly business of seeking new oil fields, the Office of Price Administration has the power to exert a great influence toward maintaining the oil supply.

It is not likely now, however, that better prices could do more than keep the ship as nearly on an even keel as possible during the war period. The trend of the ratio of supply to consumption has changed so greatly to "unfavorable" that it must almost certainly continue unfavorable for an indefinite time.

Only the miracle of early discovery of half a dozen Golden Lanes and East Texas fields is likely to prevent the supply declining sharply during the war.

By the time war ends, the drilling shortage will have left a "gap" that will require at least two or three years of heavier or abnormal drilling to fill, with no certainty that the deficit ever will be made up.

War has not caused that change in basic conditions of oil supply that now make the future doubtful; but has accentuated and added to those conditions in such ways as to make the doubts graver.

The United States oil business was already nearing if not in a great turn in general trends such as was experienced at the beginning of this century when oil supply and demand both began accelerating phenomenally; or about 1911, when began a long period of scarcity of crude oil, in proportion to consumption; or about 1927, when an era of great abundance began. War or no war, the change was at hand. In building up a great reserve of oil upon which so much depends, the United States oil industry has shot its hunting grounds over so closely that it has exhausted the best hunting temporarily at least.

"This does not imply that there do not remain important unknown fields yet to be found. It is a fact, however, that oil is becoming harder to locate, as each new discovery made simply means one less for the future."—*(From the recent analysis of reserves presented to WPB and the Cole Committee by the Petroleum Coordinator's office.)*

A Period of Scarcity

The United States has already experienced one long period of short supply of petroleum, when the oil drills, although paid much more for their product than now, were often unable to meet the full demands of a consumption willing to pay two or three times as much for oil products as the American public has paid in the last 10 or 12 years.

The statistics of that period show how hard it is for the drill to reverse an unfavorable great trend in the crude oil supply.

It is an extraordinary fact that—more than 20 years ago—it once required 5 years of drilling at the rate of about 90 percent of that of the last five years (1937-1941) to maintain an average United States oil production of about 30 percent of the average of the period 1937-1941. In the 5 years, 1916-1920, 136,700 holes were completed in the United States; total production of that 5 years was 1,815,000,000 bbl. In the 5 years, 1937-1941, 149,400 holes were completed; production was 6,205,000,000 bbl.

In one of those "old" years, 1920, more holes were completed in the United States than in any other year before or since.

In comparison with consumption, the drilling in 1916-1920 was more than 3 times as great as at any time since. The trouble then was precisely the same as that now looming in the early future—an unfavorable discovery trend, exhaustion of high-yield drilling areas, and the necessity of an extraordinary amount of drilling in low-yield areas around old fields in order to maintain supply.

The following table gives a statistical picture of the 1916-1920 period, with its antecedent and following years, and shows that highest prices in 50 years finally got results, but only after a long period of scarcity.

Year	*Average U. S. Price*	*Holes Completed*	*Total U. S. Oil Output, Bbl.*
1911	$0.61	13,768	220,000,000
1912	0.74	17,180	225,000,000
1913	0.95	25,400	250,000,000
1914	0.81	23,100	265,000,000
1915	0.64	14,200	280,000,000
1916	1.10	24,600	300,000,000
1917	1.56	23,400	335,000,000
1918	1.98	25,700	355,000,000
1919	2.01	29,200	380,000,000
1920	3.07	33,900	445,000,000
1921	1.73	22,000	470,000,000
1922	1.61	24,700	555,000,000
1923	1.34	21,900	725,000,000

The period of shortage actually began in 1911. Beginning with Spindletop in 1901, the wildcatters had proved areas of high-yield territory throughout the country, but by 1911 the high-yield areas were being drilled-up and discovery was in an unfavorable trend. As will be seen from the table, prices began advancing in 1911 and moved steadily upward through 1913—the last advance on that rise was in early 1914. As a consequence of better prices, drilling increased enormously, and 1913 established a record up to that time with 25,400 holes, a record higher than the average of the last ten years, 1932-1941. Yet that extraordinary amount of drilling was able to increase annual output only by a small percentage.

As the output in 1913 was a quarter of a billion barrels or one-sixth of the minimum requirement estimated for 1942, the amount of drilling then necessary to maintain such a small output, comparatively, is a dismal augury of what the drilling business might eventually have to do unless the present unfavorable discovery trend is reversed.

But the worst of the period of shortage was yet to come.

The shortage trend was reversed temporarily through the next 18 months, 1914 and the first half of 1915, by discovery and rapid open-

flow development of the country's greatest oil field up to that time—the Cushing, Oklahoma, Bartlesville Sand twin-pool. Had it not been for the great flow of fine gasoline-crude from that field, the First World War might have been much prolonged. It was Cushing that permitted Lord Curzon of England to say, in November, 1918, "The Allies floated to victory on a wave of oil." Even Cushing was not sufficient to win the war. It took the Golden Lane in Mexico, just as Cushing collapsed, to keep supply up to the amount necessary for victory for the Allies.

Despite its great underground inventory, Cushing was soon out of the picture. Old methods of "capture" were then the rule. Conservation of natural lifting energy was unheard of. By rapid development on close spacing, blowing in of "wet gassers," and wide-open flow, the field's gas pressure was exhausted by the time of peak output, and production there then declined so precipitately that the totals dropped from 305,000 bbl. a day (spring of 1915) to 120,000 bbl. a day in four months. Except for providing abundance for a year and a half, adding 50,000,000 bbl. to storage, temporarily demoralizing prices and checking general drilling, Cushing's influence disappeared almost like a burst bubble, leaving a sharper shortage at wellheads than before its discovery. Even though its flow caused production of other areas to be choked back, the Cushing production did not make much change in the United States annual output, but its effect can be seen in the 1915 drop in prices and drilling. It had other effects, of which the public was taking notice before the end of 1915, sharply rising prices of petroleum products, due to the demand of increasing automobiles, United States industry supplying war machinery to England and France, and to oil purchases by the latter. Of all profane expostulation that ever broke forth from the American public, none has surpassed the agitation of early 1916 against steeply-climbing gasoline prices. As it was a bidder's market, with the supply short, the oil business could do nothing to stop the rise in prices. Three different federal investigations were going simultaneously, one by the Federal Trades Commission, another by the Interior Department on Congressional order, another by the Department of Justice. Findings summed up, in substance, that high prices were due to heavy demand and short supply.

Shortage Despite Heavy Drilling

With Cushing's decline began five years of scarcity, 1916-1920, when the necessity for more drilling was a frequent subject of public discussion. During the war years, 1917-1918, instead of hiding the shortage from the enemy, it was thought more important to advertise it as strongly as possible, in order to stir the oil industry to still greater efforts to get more oil to the top of the ground. Then, as now, an advisory committee of prominent oil men sat at Washington much of the time, to aid in coördinating the petroleum business with the war machine. The chairman of that committee, Alfred C. Bedford of the Standard Oil Company of New Jersey, asserted his leadership in the efforts to maintain and increase the United States oil supply. The gravity of the shortage is shown by a statement he issued at Washington in July, 1917:

"In view of abnormal conditions, it is peculiarly important that the country should understand the serious conditions now prevailing in the petroleum industry. This country is now producing crude oil at the rate of about 300 million barrels annually, and using it at the rate of about 335 million barrels a year. The country is absorbing the entire current production and drawing very rapidly upon its reserve supplies."—*(The "reserve supplies" at the time he was speaking were only what oil was in tanks aboveground, some 164,000,000 barrels. There were no underground reserves of immediately available surplus then.)*

Oil drillers were told that they were as valuable as soldiers. To find a new oil field would contribute to victory as emphatically as a well-aimed cannon. The most extraordinary drilling boom the country ever engaged in, in its reckless expenditure of money and in the number of important producers who took part in it, began in 1918, when for awhile it was hoped that a vast and valuable oil reservoir had been discovered in North Central Texas—the Ranger boom.

The 1917-1918 War Administration allowed prices of crude oil to be advanced to the highest point in several decades as a stimulant for drilling. And drilling was heavy, on the average as heavy as that of the last 10 years, 1932-1941. But the great trend—which seems to depend utterly on discovery—was still against the drill. That venturesome and speculative interest that often gets best results in seeking new oil fields was not yet sufficiently stirred, and wouldn't be for 2 or 3 years. In 1916, 24,600 completions had been able to add only 20,000,000 bbl. to annual output; 23,400 wells in 1917 had added only 35,000,000 bbl. to the annual output; 25,700 wells in 1918 added only 20,000,000 bbl. Approximately 74,000 completions in the three years, aided by imports from the Golden Lane in Mexico and other Mexican areas, could not quite keep output of crude oil up with a consumption not quite one-third of what it is today. There was plenty of drilling, but it hugged the shore, the low-yield locations in older fields.

In 1919, oil prices broke away from the "frozen" war levels and drilling increased to 29,200 completions, which were able to boost the annual output total only 25,000,000 bbl. Scant above-ground stocks were still declining. Toward the end of 1919 came a development that shows the narrow margin of supply on which the business was then working. It was reported that salt water had drowned some of the Mexican gushers that had done so much to save the situation for the war boards in 1917-1918. There was a wild scramble for crude oil contracts. Prices of crude oil shot upward. Alarmed at fears of chronic shortage in the United States, England went into the oil business as a governmental policy, as a stockholder in the Anglo-Persian Oil Company, in an effort to develop supplies of its own. American, English, and Dutch oil interests rushed for South American concessions. In the United States, there was a boom in the mountains of the High West, to lease oil-shale deposits.

By March, 1920, average Mid-Continent crude was bid up to $3.50 per bbl., pipe-line quotations, with many contracts at higher prices. Pennsylvania crude was posted at $6.10. The average price of crude oil was higher than it had ever been before, except in the formative days of the industry. The public was not only paying prices for gasoline that would lift the roof of the Capitol at Washington today, it was begging for more of it. In the summer of 1920, gasoline was rationed to customers by distributors in California.

But the wide advertising of the great opportunity for ventures in oil exploration had at last attracted enough new initiative and different talent—even discovery might require new blood occasionally—to change the discovery trend. By the end of 1920, with its championship record of 33,900 holes drilled in the United States, new discoveries were being reported from all directions, with wildcat wells being drilled wherever oil was thought possible. The carry-over of the discovery work into 1921 made that year rich in new fields, despite a sharp drop in general drilling due to collapse of oil prices simultaneously with the 1921 depression. Shortage of oil ended with early 1921; but it took six years more, until 1927, to find enough new high-yield drilling for the fields to begin to develop, in underground reserves, a margin of surplus oil that could be raised to the top of the ground immediately if necessary.

The period of shortage, or of little or no margin between supply and demand, actually continued 17 years, from 1910 to 1927.

It is important to note that the five years of greatest shortage, 1916-1920, were in the face of constantly rising prices and a constant increase in drilling, and no great increase in consumption as consumption has increased in recent years. Draft on United States oil fields increased only 145,000,000 bbl. from 1916 to 1920. In this five years were completed an annual average of 27,360 holes, almost 10 percent more than the annual average of completions in the United States from 1932 to 1941, inclusive. (In the last 10 years, 1932-1941, 242,539 holes were drilled in the United States, an annual average of 24,254.)

The trouble during the period of shortage was due to the unfavorable discovery trend then prevailing. Without discovery, there is lack of high-yield drilling. At that time there was plenty of room amidst and around old fields for low-yield operations. It was this kind of drilling that accounted for the large number of completions during the 1916-1920 period. The price was so high that low-yield operations were very heavy. But it requires several low-yield wells to equal one high-yield well. Why the United States in the last 10 years, or up until 1938, has been able to produce three times as much oil as was produced in 1920, with less drilling than in 1920, is because of the abundance of high-yield territory disclosed by the favorable discovery trend that began, in a large way, in 1927 and continued until 1938.

Should Begin to Amortize

Under normal conditions, the oil industry would now be thinking of getting back some of the huge capital tied up in existing oil reserves instead of planning still heavier expenditures for exploration and discovery work; or, with new discovery now so important, would be advancing oil prices as a matter of preserving capital. Common fairness to its stockholders would demand such a policy. Amortization of some of the investment in holes in the ground—43 percent of the total invested capital of the entire United States oil industry*—becomes necessary when underground reserves begin declining, else, when the oil is gone, that much capital is lost. For more than ten years prices have been too low for such amortization, or for dividends to which stockholders ordinarily are entitled.

"A review of the dividend record of the 20 major oil companies (from 1924 to 1938, inclusive) indicates that the rate of dividends paid has been less than the average rate of dividends paid by industrial corporations."— *(Report of the Temporary National Economics Committee.)*

A board sponsored by the present national administration, the Temporary National Economics Committee (T.N.E.C.), was not partial to the oil industry, but tried to be fair. Its table on the returns to stockholders made by the 20 majors is as follows:

Year	*Amount*	*Percent on Book Value*
1924	$122,400,000	3.4
1925	132,700,000	3.3
1926	200,900,000	4.4
1927	213,900,000	4.7
1928	214,600,000	4.4
1929	395,100,000	7.2
1930	273,600,000	4.8
1931	207,700,000	3.6
1932	140,000,000	2.6
1933	97,700,000	1.8
1934	118,700,000	2.4
1935	127,800,000	2.5
1936	318,400,000	6.1
1937	269,700,000	4.9
1938	195,000,000	3.3

The T.N.E.C., quoting from Standard Statistics, Inc., added the comment, *"All studies of the subject leave the strong impression that the . . . policies which have permitted creation of huge plant facilities and the building up of large volume have tended to reduce the proportion of earnings available for stockholders."*

Obviously, with a large part of its gross earnings being constantly drilled back into the earth, because of the policy of building up reserves of crude oil, the business has had to cut its stockholders short in the matter of dividends. This tendency to subnormal net earnings was stronger because the surplus oil in reserves worked bearishly against the refining and marketing branches of the business at all times.

But the major companies have done no worse than smaller ones. The entire business, from the leading oil company down to the lowliest small drilling partnership, all have had to bear the burden of the oil policy, which has given the United States perhaps the greatest of all assurances that it will emerge a victor in the gravest war in which it has engaged—the crude oil reserves built since 1927.

It is probable that even the largest oil company is suffering right now from the sinking of its tankers, the destruction of its Far Eastern holdings, shrunken sales in its domestic territory, as much as the smallest producing partnership, from the 33 percent reduction in its output, due to transportation troubles, and the restricted 60 percent of materials allowed it for continuation of its drilling operations.

Once the richest of dividend-paying businesses, the oil industry lost that distinction in 1920, its last year of rich earnings. Very few of the large companies have reported earnings in later years equal in actual dollars, forgetting percentage, to those of 1920, although all the major companies are now immensely larger and with immensely greater assets working in the business. Following are three tables on three large companies, the Standard Oil Company (New Jersey), the Standard Oil Company of California, and the Gulf Oil Corporation, showing their earnings and total assets each year since and including 1920.

STANDARD OIL COMPANY (NEW JERSEY)

Year	*Net Earnings*	*Total of Book Assets (Gross)*
1920	$164,461,000	$1,102,312,000
1921	33,845,000	1,115,939,000
1922	46,242,000	1,123,760,000
1923	56,295,000	1,148,004,000
1924	81,016,000	1,244,940,000
1925	111,231,000	1,369,170,000
1926	117,652,000	1,541,945,000
1927	40,422,000	1,426,601,000
1928	108,485,000	1,572,267,000
1929	120,912,000	1,767,377,000
1930	42,150,000	1,770,993,000
1931	8,704,000	1,919,010,000
1932	282,000	2,180,211,000
1933	25,084,000	1,912,234,000
1934	45,618,000	1,941,709,000
1935	62,863,000	1,894,814,000
1936	97,774,000	1,841,849,000
1937	147,993,000	2,060,815,000
1938	76,053,000	2,044,635,000
1939	89,128,000	2,034,989,000
1940	123,886,000	2,071,537,000

STANDARD OIL CO. OF CALIFORNIA

Year	*Net Earnings*	*Total of Book Assets (Gross)*
1920	$41,655,000	$245,755,000
1921	33,588,000	276,733,000
1922	27,019,000	305,957,000
1923	24,442,000	341,984,000
1924	26,601,000	352,804,000
1925	30,953,000	373,722,000
1926	55,122,000	573,808,000
1927	40,210,000	579,308,000
1928	46,083,000	589,989,000
1929	46,633,000	604,724,000
1930	37,675,000	610,296,000
1931	14,559,000	590,729,000
1932	13,994,000	578,009,000
1933	7,546,000	567,759,000
1934	18,327,000	569,108,000
1935	18,594,000	579,538,000
1936	23,310,000	586,103,000
1937	41,254,000	596,334,000
1938	28,875,000	605,137,000
1939	17,882,000	628,618,000
1940	19,171,000	623,199,000

The sudden jump in net earnings and assets from 1925 to 1926 was due to absorption of the Pacific Oil Company, the table thereafter reflecting the consolidated balance sheet and earnings statement.

GULF OIL CORPORATION

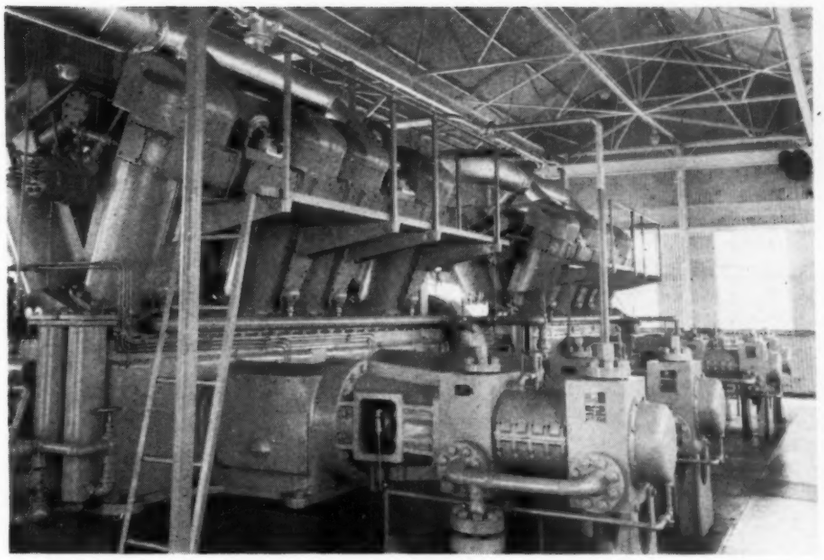
Year	*Net Earnings*	*Total of Book Assets (Gross)*
1920	$26,400,000	$259,729,000
1921	9,068,000	272,744,000
1922	19,752,000	348,378,000
1923	14,323,000	335,498,000
1924	19,166,000	379,573,000
1925	35,000,000	427,610,000
1926	35,098,000	499,337,000
1927	13,717,000	347,241,000
1928	36,325,000	381,734,000
1929	44,489,000	430,845,000
1930	10,625,000	488,723,000
1931	(d) 23,658,000	452,737,000
1932	2,743,000	435,860,000
1933	(d) 11,386,000	427,600,000
1934	2,811,000	421,984,000
1935	10,551,000	430,245,000
1936	26,356,000	442,029,000
1937	31,854,000	560,349,000
1938	13,017,000	546,870,000
1939	15,315,000	523,292,000
1940	22,150,000	523,178,000

(d) Deficit.

☆ ☆ ☆

*That 43 percent of the fifteen-billion-dollar investment of the United States oil industry is in producing properties, is a statement taken from the bill of complaint of the Department of Justice in the 1940 anti-trust action—The United States vs. The American Petroleum Institute, et al.

Gas is discharged to input well at pressure of 3400 lb. by two 650-hp., V-angle compressor units



Construction and Operating Features of East Texas Cycling Plant

Operating at a present capacity of 42,500,000 cu. ft. a day, 34,000,000 cu. ft. is returned to producing zones at pressure of 3400 lb. per sq. in.

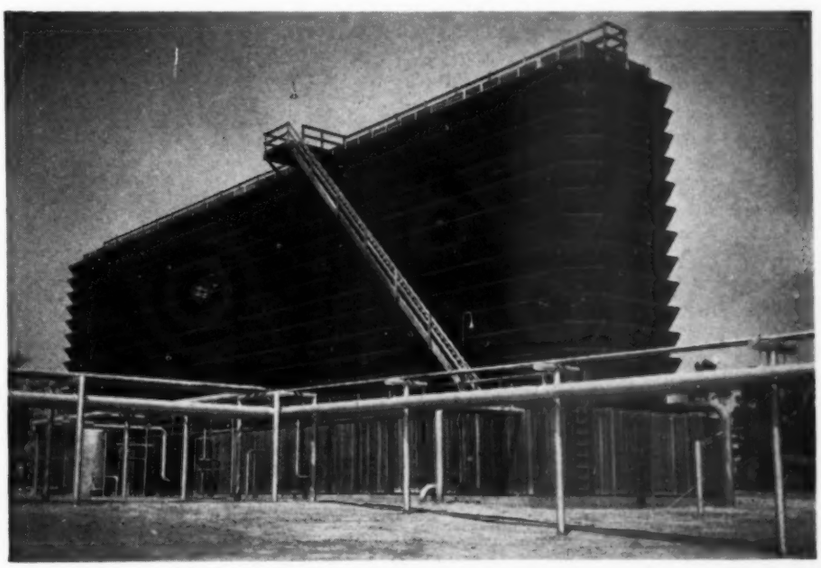
by Frank H. Love
Managing Editor

THE cycling plant recently placed in operation in the East Texas field, owned by Lone Star Gasoline Company-R. Lacy et al, constructed and operated by Lone Star, is designed for a throughput of 50,000,000 cu. ft. a day, although at present approximately 42,500,000 cu. ft. is being handled. Of this volume 34,000,000 cu. ft. is being returned to two producing sands after being stripped of its gasoline content, 8,000,000 cu. ft. is sold to pipe lines, and fuel and shrinkage account for 1,500,000 cu. ft. a day.

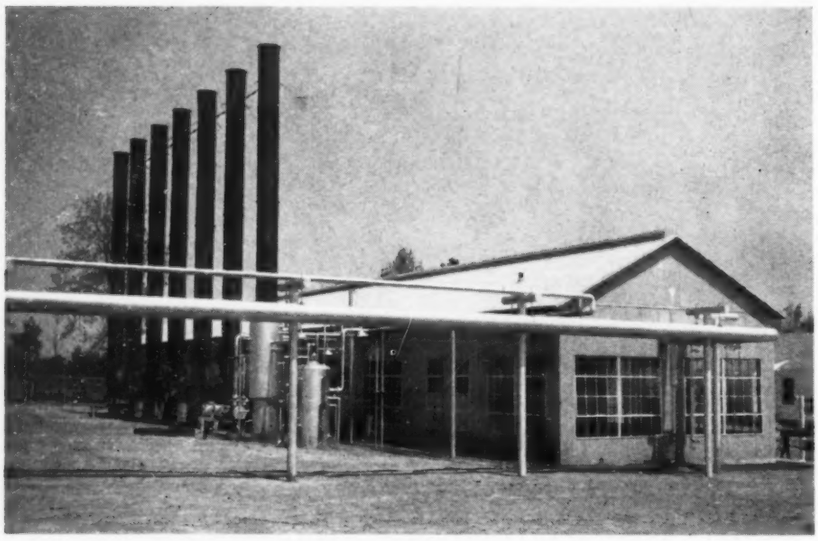
Supply to the plant is from 6 condensate wells, 5 of which are producing from the Pettit sand at a depth of 7200 ft., and one from the Rodessa sand at a depth of 6800 ft. Shut-in pressure of these wells is 2750 lb. and when open to the gathering lines the pressure is approximately 2200 lb. at those wells fartherest from the plant. Pressure drop between that point and the plant approximates 200 lb.; the gas thus reaches the latter at 2000 lb., the operating pressure of the plant.

The gathering system consists of 6-in. trunk lines and 2½- and 3-in. laterals.

As a part of the gas is delivered to pipe line and a part cycled, the plant is equipped with high- and low-pressure systems. The pipe-line gas (that in the low-pressure system) is taken off the inlet header without being cooled and passed through a steam-jacketed line, consisting of a 4-in. pipe inside an 8-in., where it is heated to 125-150°F. A regulator reduces the pressure of the gas to 650 lb. Heating the gas prevents the regulator from



The 22-bay cooling tower has a capacity of 3000 gal. per min.



Seven 100-hp., oilfield-type boilers provide plant steam

freezing and by so doing it is possible to reduce the gas to 650 lb. from 2000 lb. with only one regulator. At this reduced pressure the gas enters the inlet scrubber where condensate is removed and the gas passes to the low-pressure or intermediate absorber, which is 41 ft. high and has an outside diameter of 48½ in. Operating pressure is 650 lb. Dry gas is discharged from the absorber to pipe line.

Gas to the high-pressure system is cooled to approximately wet bulb temperature in the cooling tower immediately upon entering the plant and before going to the high-pressure inlet scrubber where condensate is removed. The gas then passes to a 41-ft. high, 54-in. O.D. high-pressure absorber, operating at 2000-lb. pressure. From here it is discharged directly to the suction of two 650-hp., V-angle type, double-acting compressors, each unit being equipped with two 4-in. by 15-in. compressor cylinders. From an intake pressure of 2000 lb. the gas is compressed to 3400 lb., at which pressure it is discharged to the injection well. This well is unusual in that dual injection is being practiced. Input to the Pettit sand (7200 ft.) is through the tubing and to the Rodessa sand (6800 ft.) through the casing. Separate meter runs measure the volume of gas returned to each formation.

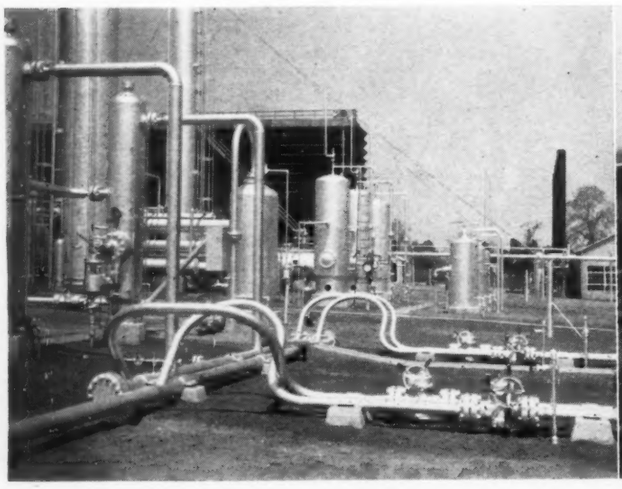
Absorption Process

Condensate removed in the 2000-lb. or high-pressure scrubber contains considerable fixed gas, and when the condensate is flashed to the 650-lb. or low-pressure inlet scrubber and mixed with the condensate in that vessel the fixed gases are released through the low-pressure or intermediate absorber where they are stripped of their gasoline content. The condensate is discharged to a vent tank operated at 250 lb. where additional fixed gases are released and utilized for fuel. The condensate is fed from this vent tank to the 6-ft. diameter by 63 ft. high still, entering near the top. Enroute the condensate is preheated by two preheaters connected in series. Both preheaters are now utilizing 50-lb. exhaust steam to impart a temperature of 285°F. to the condensate, although in one preheater 300-lb. live steam can be used to raise this temperature to 400°F.

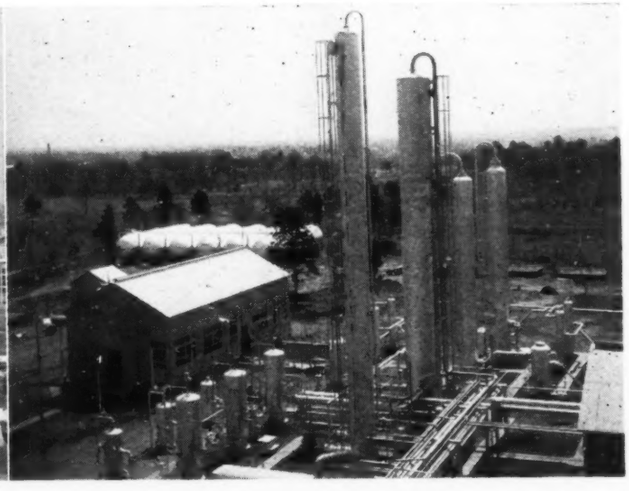
Rich oil leaving the high-pressure absorber is flashed into the base of the intermediate or low-pressure absorber where its fixed gases are released and stripped of gasoline content. Total rich oil from the two absorbers leaves the intermediate absorber and is discharged to the high-pressure rich oil vent tank, operating at 250-lb. pressure, thence to a low-pressure rich oil vent tank that operates at approximately 75 lb. Vent gases from both vent tanks are utilized as fuel. Rich oil from the low-pressure vent tank passes through oil heat exchangers, leaving at a temperature of 300°F., then through a steam preheater before entering the still at a temperature of 400°F. In the still, which is operated at a pressure of 40 lb., the rich oil is stripped of its gasoline content by steam distillation.

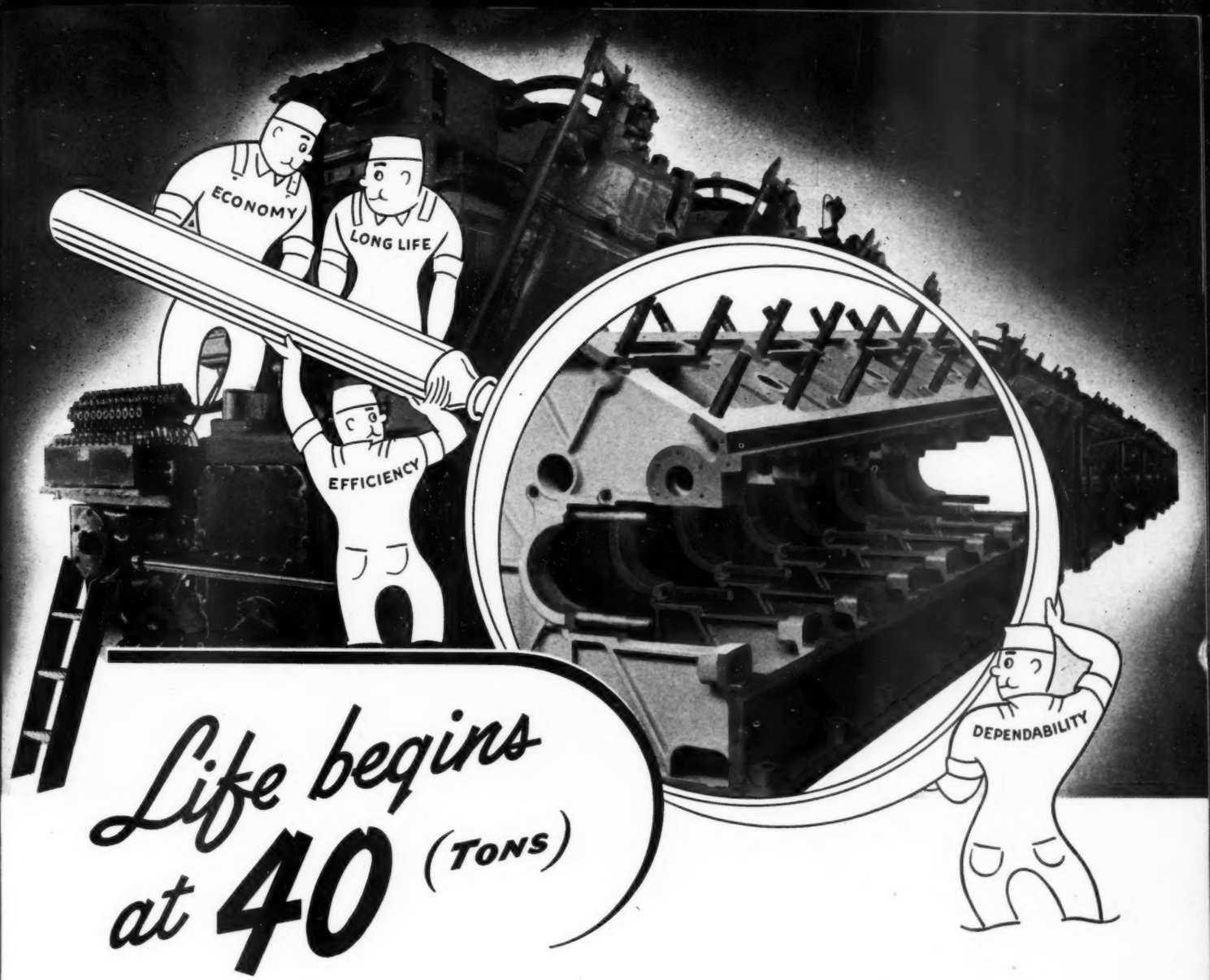
Lean oil, upon leaving the still, is first reduced in temperature to 100°F.

Suction and discharge lines to the compressors



"Aerial" view of processing area taken from atop the cooling tower





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FORTY tons of Meehanite Metal—toughest, strongest kind of iron—form the mighty castings of this 10-cylinder Type G-MV compressor, the rugged skeleton which supplies strength and endurance for a long life of profitable, satisfactory service.

Note the massiveness of the structure, the great steel studs that hold the power cylinders, the unique jaw construction that permits quick and easy removal of main bearings, or even crankshaft, from the side of the unit.

There are other important advantages, too, such as the compact V-angle design, low-pressure Streamlined Scavenging, Silent-Scot fuel system, oil-cooled pistons, pressure lubrication and interchangeable precision-type bearings.

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Convertible from gas to diesel fuel, Type G-MV is built in 400, 600, 800 and 1000-hp units, with a full range of compressor cylinder types.

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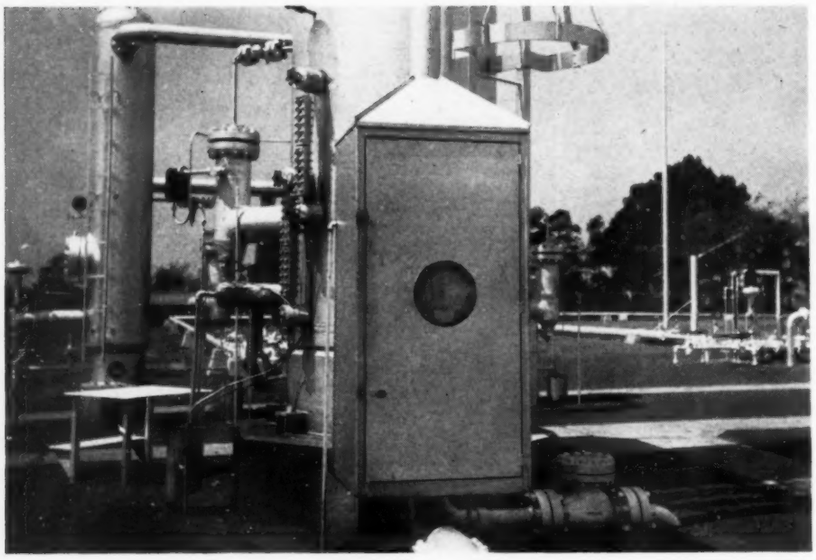
ENGINE BUILDERS SINCE 1833



Flow meter on high-pressure absorber outlet

by heat exchangers, then further reduced to 80°F. by passing through coolers in the base of the cooling tower. From there it is discharged to the lean oil surge tank from where it is picked up by the lean oil pumps and returned to the absorbers to begin another cycle.

Overhead vapors from the still are cooled in primary condensers to approximately 150°F. from a still top temperature of about 270°F. Water is separated from the vapors at this point into a dewatering tank and discharged to the boiler feedwater tank. Gasoline and vapors leaving the dewatering tank pass through secondary coolers where the temperature is reduced to 80°F., into the raw make tank, which is a horizontal vessel 8 ft. in diameter and 30 ft. long. A small part of the liquid is returned to the top of the still to control top temperature. The remaining liquid, which tests 25 lb. Reid vapor pressure, is discharged to the depropanizer where all propane is removed, the kettle product being of approximately 11.5 Reid vapor pressure. This product is sent to storage, which consists of six horizontal, hemispherical-head, 12-ft. by 60-ft. tanks, each having a capacity of 49,000 gal.

During the course of processing, a drawoff cut is taken from the side of the still. This cut consists of ends too heavy to vaporize and go out through the top of the still and too light to remain in the circulating oil. The cut is drawn off by manual control from a drawoff tray and is mixed in the storage tanks with the depropanizer bottoms. The resulting plant product is a depropanized condensate of 10.9-lb. Reid vapor pressure.

Steam System

Seven 100-hp., oilfield-type boilers having a working pressure of 300 lb. provide steam for the plant.

The steam system is closed and about 75 percent of the boiler makeup water is condensed steam. The other 25 percent is obtained from a nearby lake. All condensate from the high-pressure steam traps is discharged into a 50-lb. condensate tank. Makeup water and condensate from the low-pressure steam trap and from the processing equipment are pumped through a shell-and-tube heat exchanger into the 50-lb. condensate tank. Exhaust steam is utilized to heat this water to approximately 285°F., and the total water accumulated in the 50-lb. condensate tank is fed to the boilers. Boiler feedwater pumps consist of two 10 by 6 by 12 duplex, reciprocating, steam-driven pumps, one of which is a standby. An 8 by 4½ by 10 duplex, reciprocating, steam-driven unit serves as a makeup pump.

All boilers are equipped with feedwater regulators. The speed of the principal boiler feed pump is controlled by a governor that holds a pressure on the feedwater header of 25 lb. above the boiler pressure. The speed of the boiler makeup feed pump is controlled by a liquid-level controller on the condensate tank.

Processing Pumps

There are two lean oil pumps, one pumping to the high-pressure absorber and the other to the intermediate absorber. The latter is a duplex, plunger-type, steam-driven pump. The high-pressure lean oil pump is somewhat unusual in that it consists of two simplex pumps synchronized to operate as a duplex, plunger-type pump. The steam end is compounded to give a high efficiency. Either side of the pump can be shut down while the other side is operating. This provides a standby feature that is not available in the usual duplex or power pump. One side also is hooked-up in a manner that it can be utilized as a standby for the lean oil pump serving the intermediate absorber.

Gasoline pumps consist of two 10 by 6 by 12 and one 6 by 6 by 12 simplex, reciprocating, steam-driven units.

Cooling Tower

The 22-bay, atmospheric-type cooling tower measures 49 ft. high, 138 ft. long, and 24 ft. wide, and has a capacity of 3000 gal. per min. Two turbine-driven, centrifugal pumps, each having a capacity of 2000 gal. per min. pump water from the base over the top of the cooling tower. Water used for cooling purposes is from a deep well. This water, however, is not suitable for boiler feed. The well is 420 ft. deep and the water is lifted by a deepwell pump belt-driven by a gas engine.

Generating Plant

Electricity is generated by a 25-kw. generator driven by a steam turbine. A standby unit consists of a 25-kw. generator belt-driven by a gas engine.

Air Compressor

A 2-stage air compressor belt-driven by a 7½-hp. motor provides starting air for the compressor engines.

Gas Analysis

Gas produced by the wells serving the plant is rather lean, providing about 13½ bbl. of condensate per 1,000,000 cu. ft. A typical sample of raw gas analyzes as follows:

Component	*Mol percent*
Methane	93.40
Ethane	3.92
Propane	0.99
*Iso*butane	0.24
N-butane	0.33
Pentanes	0.23
Hexanes plus	0.89
	100.00

Disposition of Product

The plant's condensate output is sold to the R. Lacy Refinery in the field and is pumped through that company's pipe line.

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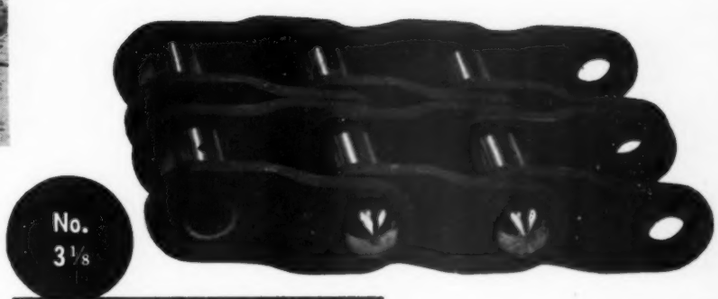

Pitch in Inches	Number Links in Approx. 10 Feet	Ultimate Strength Pounds	Weight per Foot Pounds
Single 3.125	39	115,000	12.6
Double 3.125	39	115,000	24.6

THE unusual performance records which Ideal Rotary Chain has created in the service of deeper and faster drilling can be attributed to the fact that this Chain has been designed and built to fit this particular service.

National engineers in designing and building machinery and equipment for modern drilling technique anticipated violent impacts and shock loads by building a chain to fit these requirements.

Material shortages and the conversion of manufacturing materials to wartime production has made chain service of increased importance today. When you rechain—reduce maintenance expense and minimize costly shut-down expense for repairs by using Ideal Rotary Chain—it is precision built, efficiently lubricated, and all parts subject to wear are made of wear resisting steels, heat treated to obtain the best combination of toughness, strength, and wear resistance.

Pitch in Inches	Number Links in Approx. 10 Feet	Ultimate Strength Pounds	Weight per Foot Pounds
No. 3 API 3.075	39	70,000	8.5
No. 4 API 4.063	30	170,000	17.2

Pitch in Inches	Number Links in Approx. 10 Feet	Ultimate Strength Pounds	Weight per Foot Pounds
ASA NO. 200 2.500	48	95,000	11.0

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Regulation to Maintain Balanced Pressure On Gas System

ROY W. PARKER

has been in the employ of the Oklahoma Natural Gas Company for 16 years, one year having been spent in the measurement department, one year in the meter repair department, four years as assistant chemist, four years as chief chemist, and the last six years as industrial sales engineer—Prior to his affiliation with Oklahoma Natural he had been employed in the refining department of The Texas Company, from 1923 to 1926—He is a graduate of Southeastern State College.

☆ **Automatic control results in constant and accurate pressures necessary for efficient operation**

by Roy W. Parker
Oklahoma Natural Gas Company

REGULATION to maintain a balanced pressure in the entire system and adequate pressure in city plant distribution lines is receiving increasing attention from the gas industry. A review of progress by the gas industry and equipment manufacturers clearly shows the constant efforts being made by each group to perfect this phase of gas utilization. Related articles on this subject tend to stress the importance of automatic control, having in mind such factors as safety, economical operation, more dependable service, improved processing conditions, and more accurate measurement.

With the steady increase in the number of gas-fired furnaces, ranges, water heaters, and other miscellaneous gas-burning equipment, most of which have been designed by the manufacturer to have a very definite fixed rate of gas consumption, it is obvious that constant and accurate pressures are necessary for efficient and satisfactory operation. Economical operation also enters into proper control and regulation of gas transmitted and distributed, as leakage and unaccounted gas has a direct relationship to existing pressures.

In order to meet the more exacting demands of new equipment and increased load it has been necessary to perfect further the methods and equipment necessary to meet this demand for more perfect control and regulation in our entire system. This desire for more accurately controlled outlet pressures than formerly existed necessitated automatic equipment as the ordinary weight-loaded regulator did not meet the desired demands. Consequently, several methods have been developed to increase the power and sensitivity of the diaphragm by the use of pilot loading and sensitizing arrangements.

Pressure Control Methods

Several methods are employed to narrow the limits of the desired pressure but most of them come under the following designs or types: (1) remote measurement and control; (2) automatic flow control; (3) time tempera-

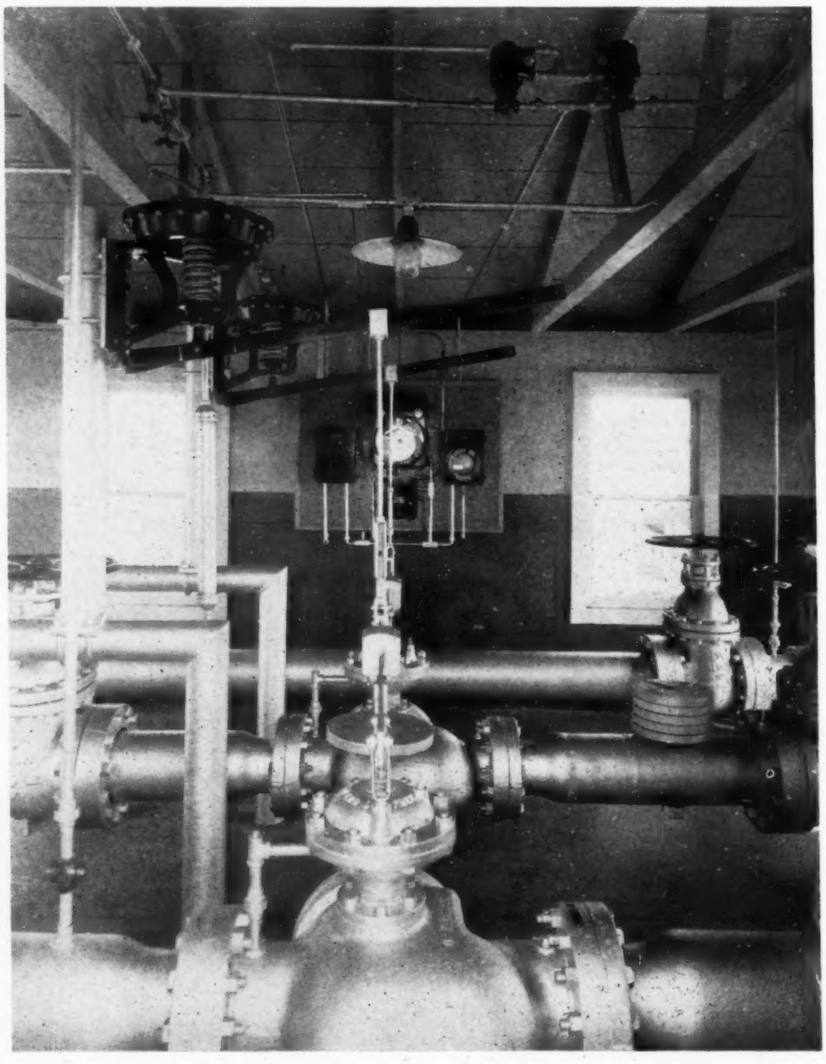

Fig. 1. Metameter or remote control system transmitter installation

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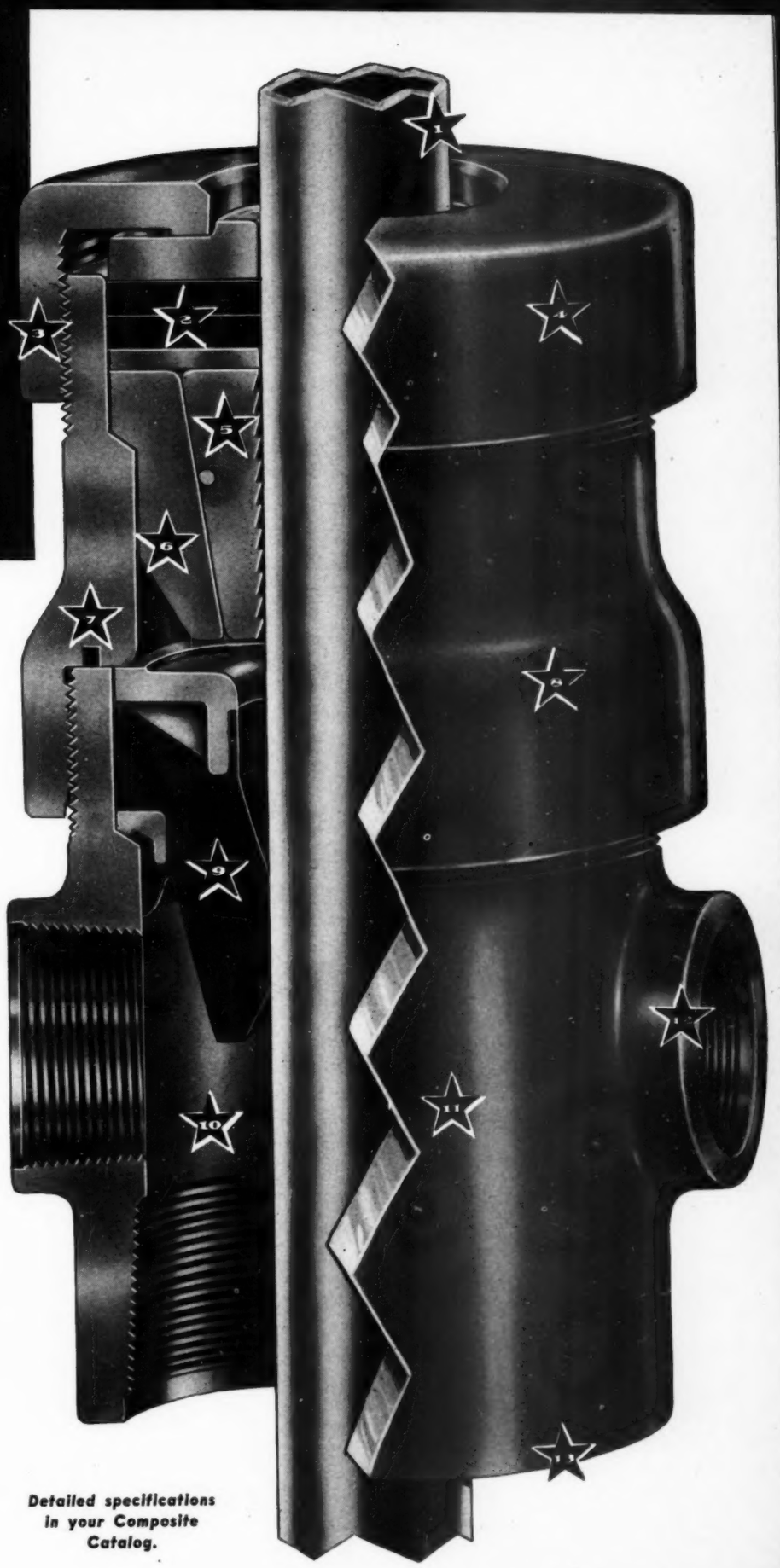

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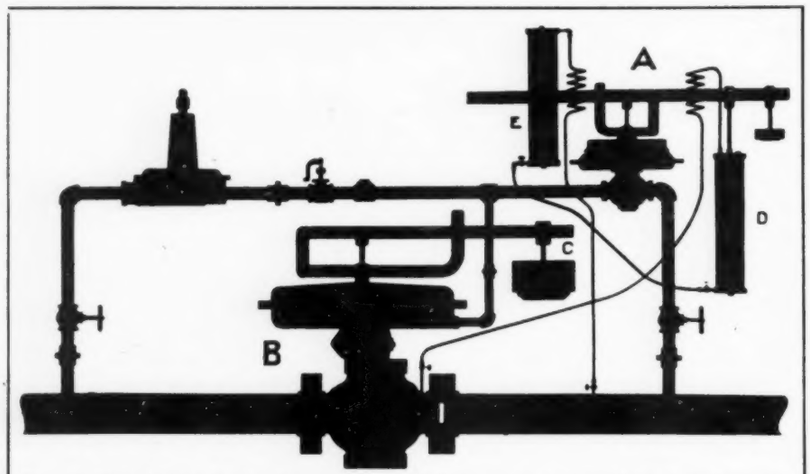


Fig. 2. Sketch of a typical governor and flow-control assembly. A is the control unit. B is the governor or master regulator. C is the pressure-weight arm. D and E designate the liquid containers actuating the control unit A

ture control; (4) velocity booster control, and (5) manual control.

Manufacturers of pressure-controlling equipment for some time have anticipated the necessity for more exacting control limits and the related benefits and have developed and put in operation varied types of the above-mentioned controlling principles.

Remote control and measurement are accomplished by means of a transmitter that measures the variable conditions, such as pressure or flow, and a receiver that records them on a chart.[1] The transmitter is connected to the receiver by a two-wire telephone circuit. This remote control is known as the metameter system of timed impulse where the value of the condition measured at the transmitter is converted into a time interval that is determined by the duration of individual impulses. The transmitter moves a pointer across the face of a rotating spiral cam or plate. This pointer is between a rocker plate and the cam and the pointer being engaged by the cam moves a magnet away from an enclosed mercury contact switch. The spiral trailing edge of the cam is designed so the intervals of time corresponding to the periods of closed circuit are proportional to the position of the pointer as determined by the conditions being measured.

The Metameter

The metameter incorporates the "free vane" mechanism in the recorder-receiver. It is equipped with wide throttling range and speed and reset adjustments to compensate for time lag. The control mechanism is supplied with air or gas at a pressure of 15 lb. The pressure at the low point is recorded by the receiver pen and through the vane mechanism automatically loads the regulator exactly in accordance with load demands.

The remote manual loading of regulators with continuous record of regulator pressures at the central point uses two pair of electrical circuits between the border stations and the control house. The inlet and outlet pressures are recorded automatically every 15 minutes on a recording chart. The operator can change the outlet pressure that feeds the intermediate system by closing a small toggle switch. Moving this toggle to the "increase" position for one minute will increase the city border outlet pressure 1 lb. and vice versa for a decrease. This is made possible by the pilot control instrument and cam mechanism briefly explained previously. This control has proved very satisfactory and it is reported that the cost of such an installation will pay out in two years in labor saving. Service calls were reduced by 50 percent after this equipment was installed in one gas property. Surges are eliminated and consistent district regulator pressure assure better low-pressure service.

Another remote controlling system employs a diaphragm motor lever operating a Wheatstone bridge. This transmitter is placed in a low-pressure area, where the outlet pressure results in a varied resistance on either side of this Wheatstone bridge that is transmitted to a galvanometer, so designed that this impulse is proportional to the actuating force at the transmitter or critical point and therefore keeps the system in balance. The essentials of this system of control are as follows: First, a throttling range that can be adjusted to suit unfavorable lags and, second, a follow-up mechanism that prevents a change in control point.

Improvements in Control

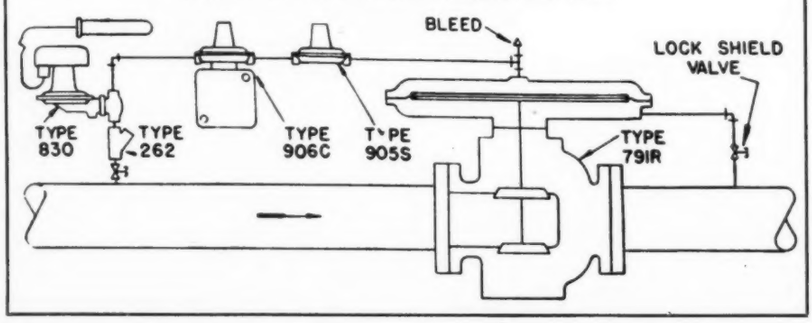
For the last several years there has been a continuous improvement in methods and equipment of the automatic flow control type of pressure control regulator. One arrangement[2] converts the differential pressure into power, exerted on liquid containers, to operate and control a pilot regulator that in turn operates the master regulator. These containers are mounted at opposite ends of the lever on the pilot regulator, and are suspended from the lever so that the top of one tank is slightly higher than the bottom of the other. The top of the lower liquid tank is connected to the upstream side of the orifice and the top of the upper container to the downstream side. With no flow of gas the liquid is in the lower tank and this weight exerts a closing action on the pilot valve. With a flow of gas the differential causes a transfer of liquid in these containers, which instantly acts as an opening weight on the pilot regulator that is transferred to the master governor.

This type control has several desirable features, including (1) installation without interruption of service, (2) custom built for individual re-

[1] "Remote Measurement and Control Instruments," by E. H. Hart and Dean D. Ault, The Bristol Company. Paper presented at Southwestern Gas Measurement Short Course, Norman, Oklahoma, 1940-1941.

[2] "Automatic Flow Control," by H. Mike Meuffels, Reynolds Regulator Company. Paper presented at Southwestern Gas Measurement Short Course, Norman, Oklahoma, 1941.

Fig. 3. A time-temperature installation. At left is the temperature controller in series with the time unit indicated as 906C



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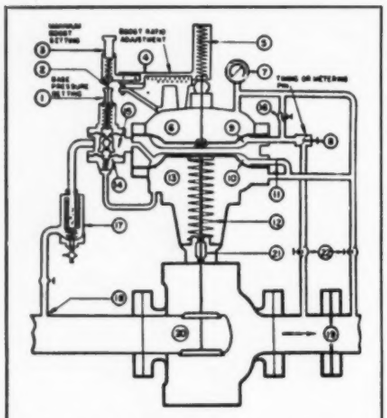

Fig. 4. Velocity booster regulator. (For "key" to numbers see text of article)

quirements, (3) range of regulation from in. of water to lb., (4) easily serviced, and (5) safety of control.

Time-Temperature Regulator

In the next group is the time-temperature pressure regulator,[3] designed to do automatically the work of increasing or decreasing the reduced pressure on a distribution system in relation to the actual demands for pressure variations in relation to both atmospheric temperature and the time of day or night. This equipment is designed to increase or decrease the gas flow using 65°F. as a basis. Experience has proved this figure to be the temperature below which a demand for heating begins. A time clock mechanism is necessary because even though the temperature is low if it occurred during the night, the demand might not be so great. The temperature controller maintains normal pressure increased to a designated time at night, usually about 10:00 P. M. At this time the secondary control maintains a constant low night pressure until the early morning load comes on. Then, the temperature-controlling device again takes over for the day.

The temperature-loading regulator is of the simple house service regulator construction with a loading mechanism applied. Mounted on this regulator is a simple leverage mechanism connected with a self-contained thermostatic temperature bulb element. This bulb and capillary tubing system is filled with fluid that is extremely sensitive to temperature changes. As the temperature changes this fluid expands or contracts and transmits a force to or from the loading mechanism on top of the regulator, thus increasing or decreasing the outlet pressure to conform with the demand.

[3]"Time Temperature District Gas Regulator," by Chas. D. Peterson, Fisher Governor Company. Paper presented at Southwestern Gas Measurement Short Course, Norman, Oklahoma, 1941.

As mentioned previously, should the temperature continue to drop after bedtime it is not desirable to continue boosting the pressure with a lower demand condition existing. To cut-out or cut-in the temperature booster feature of this system, a time clock and regulator unit is used. The clock is a conventional meter clock that can be electrically or mechanically driven. An adjustable cam that makes one revolution in 24 hours is attached to the clock post. By means of a leverage arrangement contacting this cam it can be fashioned to place the regulator in operation at any predetermined time. Incorporated in the entire installation is a maximum booster limit regulator that serves to check the temperature control unit in the event that even lower temperatures exist and the distribution system has reached the desired 8 ounces.

Velocity Pressure Booster

The velocity type pressure booster[4] is another regulator from which very good results have been reported. As with other types this booster automatically increases the reduced pressure to compensate for increased load demand. Fig. 4 shows such a regulator. The controller is essentially a gas-pressure-loaded, constant-pressure regulator plus an extra loading diaphragm assembly mechanism that receives its loading power by means of the differential pressure across an orifice plate in the downstream or reduced pressure area. The controller is arranged with maximum and minimum pressure stops or limiting factors that make it flexible for all general distribution systems.

In the sketch of this booster, disregarding the lever arrangement, 4, the upper chamber, 6, and the downstream orifice plate, 19, there is only a spring-closed, pilot-operated, constant-pressure regulator.

In the manual control group are many makes and types. This type is the pioneer of gas regulation as they served as the regulating motive from which later came the automatic type. Unlike other regulators they are composed of three essential parts: (1) the valve body and inner valve, (2) the diaphragm or pressure element, and (3) the loading device or source of power for operation. The source of power for this group is a weight-loaded lever acting on the diaphragm or a spring tension exerted on the controlling part.

———☆☆☆———

[4]"Velocity Type Pressure Controls," by D. B. Hutchcraft, Fisher Governor Company. Paper presented at Southwestern Gas Measurement Short Course, Norman, Oklahoma, 1941.

Fig. 5. Upper chart shows variation in pressure before the remote control system was installed. Lower chart shows how line "smoothed out" afterward

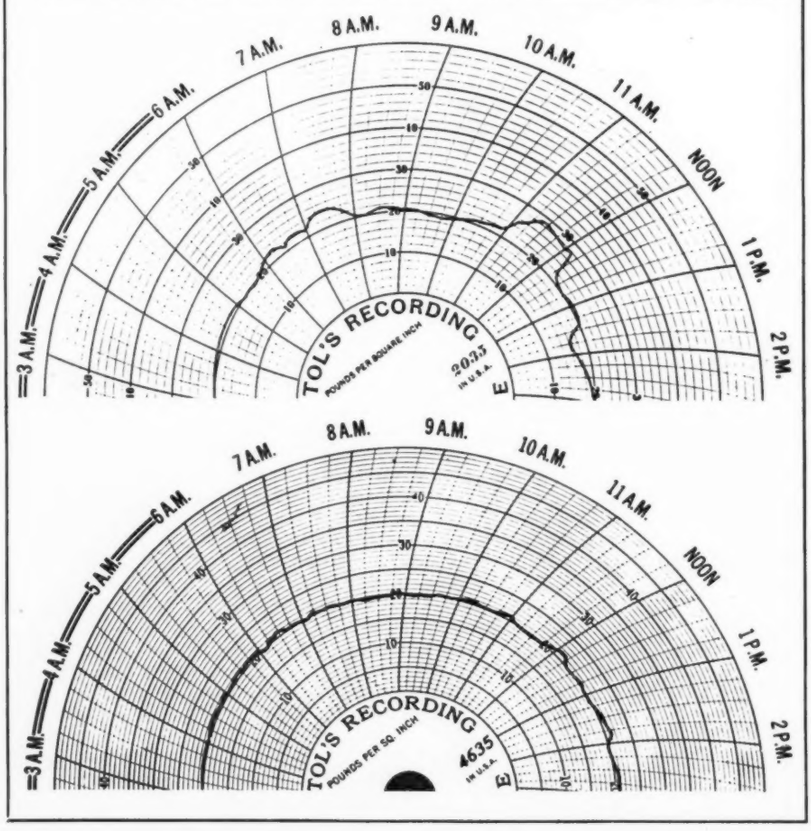

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Fig. 1. General view of one of the pits constructed by the company to collect salt water from the leases for sterilization before piping to final treating plant

PETROLEUM ENGINEER Exclusive Feature

by C. C. Pryor
Assistant Editor

Salt Water Disposal System Utilizes Non-Corrosive Materials

☆ Chlorine for sterilization generated by rebuilt electric-welding machine, solving problem caused by W.P.B. restrictions on purchase of chlorine

IN recent years in all areas where salt water has been encountered in the production of oil, the disposal of the salt water has been recognized as an expensive and difficult problem by operators and as a result has required, in many instances, their unified efforts for a successful solution.

Today, in nearly all fields where salt water presents a production problem, there are some highly successful disposal systems. These systems may or may not have been the product of unified effort on the part of operators, but may represent the result of careful research and study by individual engineers of their particular problems.

The various problems encountered by one operator in designing and operating a disposal system are not always the problems of an operator in another area. The common problem of all salt water disposal systems and the most outstanding is that of corrosion to pipe, tanks, pumps, and other material used in the system.

One of the major companies operating in eastern Texas fields has designed and placed in operation a salt water system that is regarded as being most successful from several standpoints.

Collection Pits

As the company decided upon a policy of returning the salt water to a formation approximately 300 ft. below the main producing zones and outside the producing area of the field, it was necessary to adopt a method of gathering the salt water from the various leases throughout the field. To accomplish this purpose, concrete pits were constructed at strategic points into which the salt water was collected from a certain number of leases. The leases were selected so that their total production of salt water could be easily handled by the pits.

Several other considerations, of relatively minor importance, entered into the selection of the sites for the collection pits. It was believed desirable to select a location in which the cut and fill would balance and also one in which the clay found at the depth of the floor of the pit would provide a satisfactory foundation. Mechanized equipment was used to dig the pit.

After the pit was dug and the loose earth used to fill and form the outline of the pit, concrete beams 12 in. wide, 3 to 4 in. deep, and reinforced with 3-in., 10 ga. black iron mesh were laid.

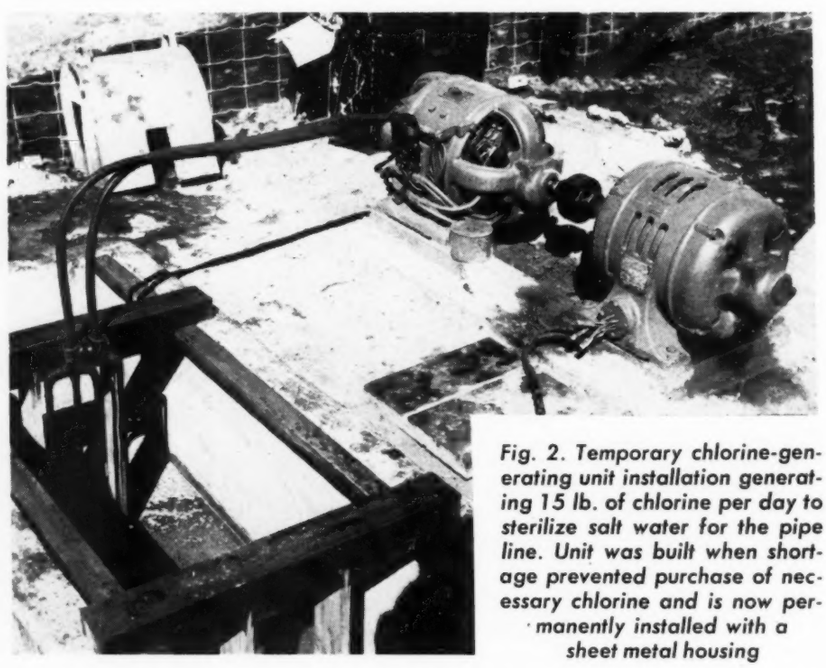

Fig. 2. Temporary chlorine-generating unit installation generating 15 lb. of chlorine per day to sterilize salt water for the pipe line. Unit was built when shortage prevented purchase of necessary chlorine and is now permanently installed with a sheet metal housing

Pomonas WERE THE PUMPS SELECTED for this model salt water disposal system!

Another Example of How Pomonas Get The Nod When Requirements Are Severe

As any operator who has had first-hand experience will tell you, salt water disposal is one job that is really *tough* on pumps. Not only must the pump operate with month-after-month dependability . . . at high efficiency with low operating cost; but it must withstand the extremely corrosive action of salt water, which at the same time contains dozens of other different corrosive elements as well!

So when one of the majors in the East Texas fields designed and placed in operation a salt water system that is regarded as being "one of the most successful in that section," it's important to note that Pomonas were picked to handle the pumping requirements!

This salt water disposal installation is just one of a score of different jobs on which Pomonas are saving money in the oil industry. Whether your pumping problem involves water for cooling and circulating operations . . . for refinery processes . . . for waste disposal . . . for rig supply . . . or for other oil industry operations, consult Pomona for the equipment that will do the job *better* at *lower* cost. There's a Pomona dealer near you . . . or write our engineering department direct!

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Pomoloy Parts: Standard Pomona pump bowls and other iron parts are made of Pomoloy—a new tough-grained, extremely hard alloy far superior to conventional cast iron. Greater abrasion and corrosion resistance, longer operating life, lower maintenance costs are the result! Special materials can be furnished to meet specific corrosion problems.

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To the beams was applied a ¼ in. coating of asphalt.

Before the concrete wall was poured the entire surface of the pit was covered with 3-in. by 3-in. mesh to reinforce the concrete that was applied by guniting.

These pits are 65 ft. by 65 ft. at the top and 41 ft. by 41 ft. at the base. The sides have a 2 to 1 slope ratio. Total capacity of the pit is 3000 bbl. Fig. 1 shows the completed pit.

As may be seen to the right in Fig. 1 a skimming sump having two compartments was constructed at one edge of the pit. The sump is approximately 10 ft. wide by 20 ft. long and 10 ft. deep. Water from the leases enters the larger compartment and any oil in the water is removed.

Sterilization

It had been the practice of the company to purchase large quantities of chlorine for treating the water in these collecting pits before it was conducted by gathering lines to the final treating pit. In the present emergency, War Production Board restrictions have resulted in the manufacturer being unable to deliver the required chlorine. As it was essential that the water be sterilized before entering the pipe line to the final treating pit, it was decided to manufacture the required product. In Fig. 2 may be seen the equipment with which the chlorine is manufactured. This equipment was salvaged from an electric-welding machine and rebuilt in the company's shop. The electric motor is a 3-phase, 440-volt, 5-hp. unit and is direct-connected to a 10-volt, 250-amp. a-c. generator.

In the smaller section of the skimming sump, four 41-in. by 7-in. by 1-in. graphite plates mounted on wooden suspenders with bakelite bolts and spacers are connected to the a-c. generator and by electrolytic action generates approximately 15 lb. of chlorine per day. The cost of the equipment was negligible as is its upkeep, the only repairs necessary being new brushes and occasional turning down of the armature of the motor and generator. Operation of the system is also intermittent, because the salt water pit is empty for a part of each day. This is due to the relatively small quantity of salt water at present produced in the field; however, the pits are of ample size to accommodate a reasonable increase.

Entering the pit from the skimming sump, the water is sterilized and is then picked up by a pump (Fig. 3) and transported through the cement-asbestos gathering line to the final treating stage.

Pumping Salt Water

It is recognized that the pumps handling salt water even after sterilization present a difficult and expensive problem. The contact of dissimilar metals has produced harmful effects for many operators. The failure of a pump in salt water use may almost be assured, if in its fabrication dissimilar metals are allowed to come into contact with each other.

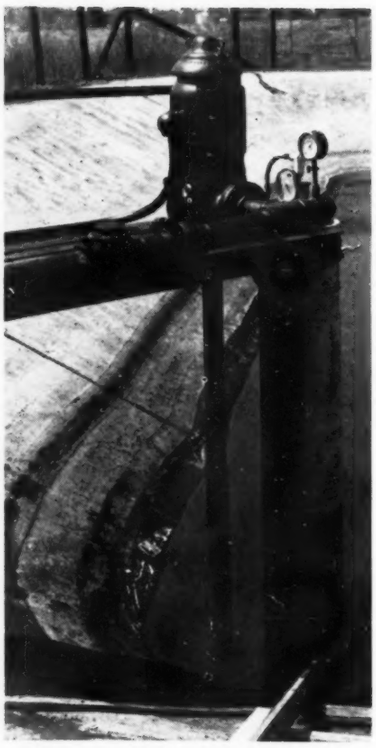


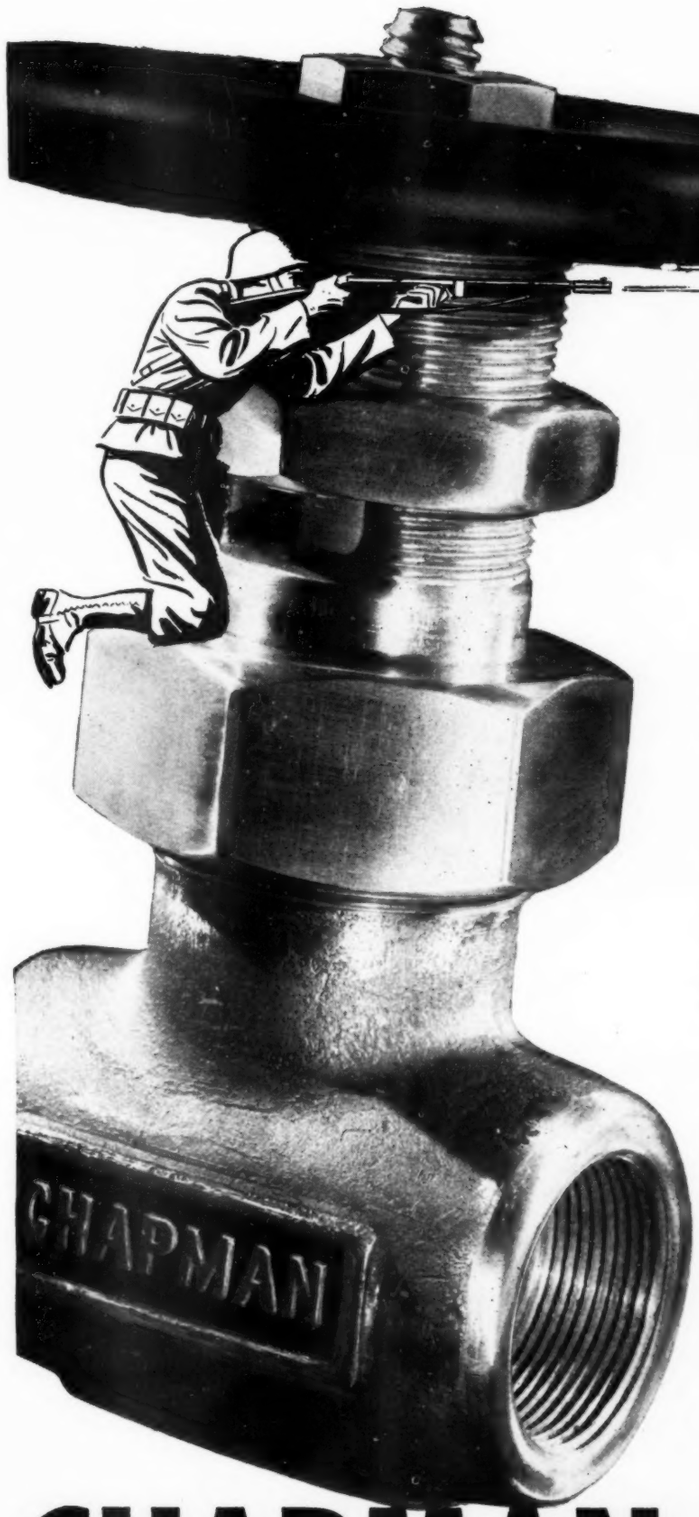
Fig. 3. Salt water pump actuated by float switch requires no priming—pump designed for maximum resistance to salt water corrosion

The pump shown in Fig. 3, and in general use on the salt water collecting pits here discussed, consists of an 11-stage turbine assembly with approximately 3 ft. of 3-in. discharge column, a surface type discharge head, and a 5-hp., 3-phase, vertical hollow-shaft motor. The pumps were designed for a capacity of 60 gal. per min. against a head of 185 ft. with an efficiency of about 83 percent.

Construction of these pumps is such that there are no metal-to-metal contacts between the rotating shaft and impellers and the stationary bowls. Similar metals are used insofar as is practicable. The bowls and impellers are constructed of a specially treated metal developed originally to combat graphitization. The metal is listed under A. S. T. M. specifications A48-36, which includes all general gray iron castings where strength is a consideration. This C-2 iron comes under Class 40 of the specification, has a tensile strength of 40,000 lb. per sq. in., a transverse test 1.20 in. round bar on 18-in. centers of 2850-lb. minimum, a deflection of more than 0.24 in., and an average Brinell hardness of 215. The bowl shaft of the pump is of stainless steel; however, the synthetic rubber bearings prevent the shaft from touching the bowls at any point. The construction and material involved are all within that considered best practice in construction of pumps for salt water service. The synthetic rubber bearings are lubricated by the water and are not affected by contact with any oil in the water as is the case with natural rubber.

As shown in Fig. 3, the pumps are installed in a vertical position and

Fig. 4. This picture shows concrete baffles used to aerate water in removal of iron oxide, chemical treating mixer and laboratory and storehouse, and final storage pit before injection of water back into sand



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have a submerged suction at all times, which eliminates priming. The elimination of priming has enabled the operator to use an automatic float switch (the top of the float switch assembly may be seen in the photograph).

Gathering Lines

The longest gathering line is approximately 6 miles in length from the collecting pit to the treating plant and disposal well on the edge of the field. The line used is of 4-in. cement-asbestos pipe and has been found entirely satisfactory in that it has not given trouble in transporting the sterilized water by becoming plugged or by reducing the volume of flow through the line.

At the treating plant (Fig 4), to remove the iron oxide, the water is aerated in a series of shallow pits designed and constructed to give the greatest degree of aeration. As shown in Fig. 4, the water first enters a skimming sump, then the first of 5 rough concrete baffles. The water flowing over the baffles does not attain a depth of more than ¾ in. Water in the skimming sump appears simply as dirty water, but on each successive baffle becomes more reddish or rusty in appearance as more oxygen from the air unites with the iron particles in the water, forming iron oxide.

Leaving the last baffle the aerated water is then treated with alum and lime and is thoroughly mixed with the chemical by means of a motor-driven rotator in a pit situated beneath the floor and in the center of the building. This equipment is shown in Fig. 5. Leaving the pit, the treated water is again aerated on two concrete baffles, similar to those described, and passes to the large collection pit seen in the background of Fig. 5. Tests of the water are made in the laboratory situated in the left wing of the building shown in Fig. 4 to determine whether the proper quantity of chemical has been added and whether the water is properly conditioned and ready for injection. The right wing of the building houses the chemicals used in treating.

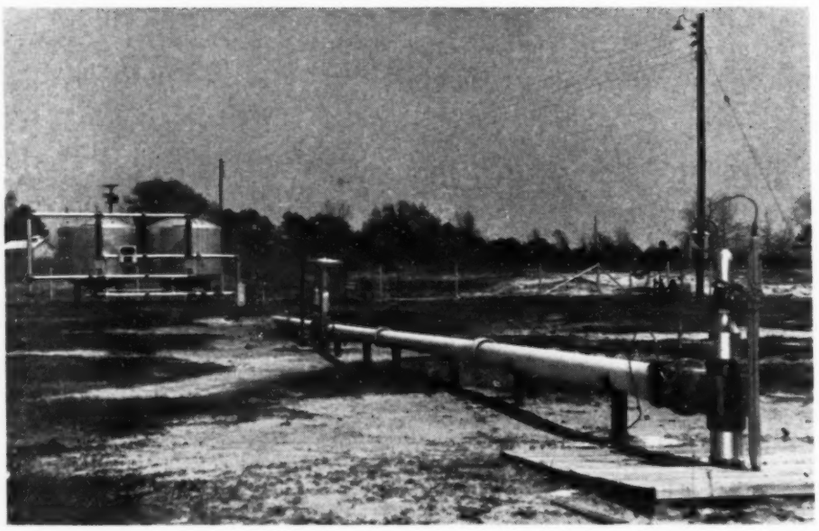
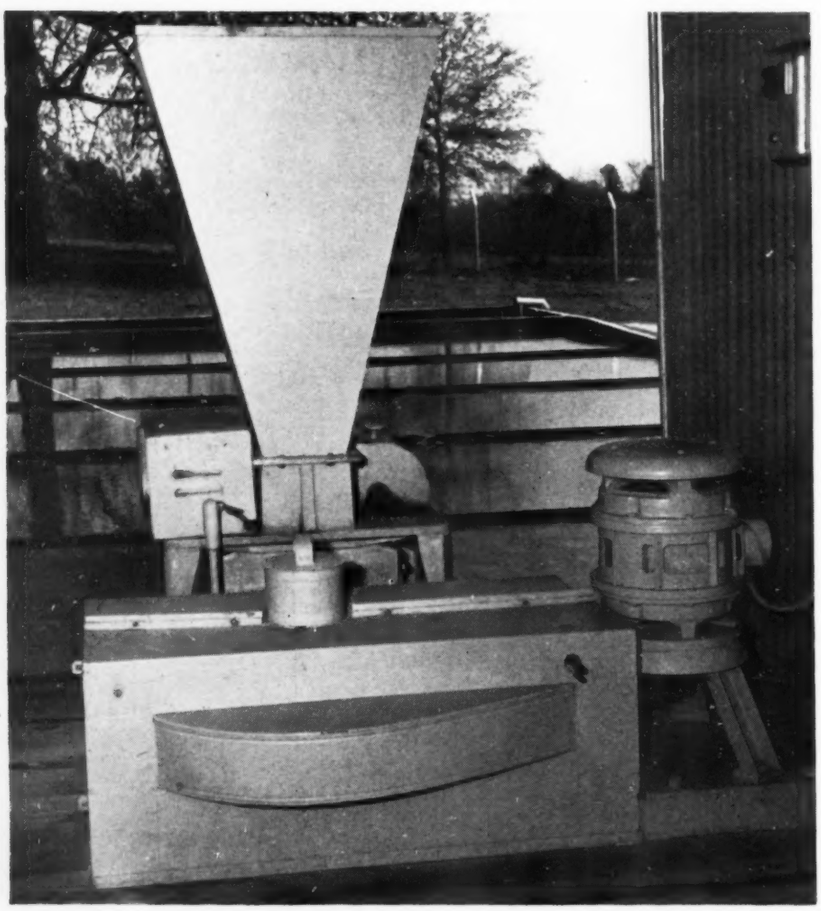


Fig. 6. In the background may be seen the sand filters, meter, regulator, and the injection wellhead. The well carries about 30 in. of mercury vacuum

Fig. 5. Closeup of chemical mixer, turned by electric motor, and hopper into which chemical is fed



As the treating plant is situated at a higher elevation than the disposal or injection well, the water flows by gravity to the sand filters shown in Fig. 6. The piping connecting the filters is of steel, as it was considered impracticable in this instance to use the cement-asbestos pipe. These sand filters are so arranged that they may be backwashed into a small pit to the right of the filters (Fig. 6) to remove any accumulation of oxides.

Leaving the filters the water is metered and passes through a regulator that holds back-pressure on the filters, keeping them full of water, as the vacuum on the wellhead would drain the water out and allow them to dry.

There is a vacuum of approximately 30 in. of mercury at the wellhead. The well tubing is 5 in. O. D., cement lined, with the bottom end opened and a packer set above the formation in the 7-in. casing.

☆☆☆

"You strand together 19 wires, and in between you weave the thread of Research"

Like the research that's responsible for this giant strander

"Many a job calls for 6 x 19 "Blue Center" Steel Wire Rope, but for those that don't, Roebling Research is ready with specialized facilities and materials. This giant strander, for example, can take as many as 46 tough steel wires, and accurately lay them into strand for pliable, high-strength, large diameter ropes, such as are used on mammoth dredges . . .

How strong is such a strand? If we want to know, this "tower of torture" will tell us. Another of the long arms of Roebling Research, it can pull apart a 4" wire rope to find its ultimate breaking strength. It also indicates how the rope will behave under *your* conditions and *your* loads . . .

But of course you know that a study of wire rope quality must cover more than breaking strength alone. That is why Roebling Research created the world's largest, most highly developed fatigue testing machine for wire rope—a giant laboratory in itself. In its 75-foot length it simulates many conditions that "Blue Center" Steel Wire Rope meets in the field, lets Roebling Research men study each condition carefully . . .

Thus the strong but invisible thread of Research is woven into every inch of Roebling "Blue Center" Steel Wire Rope. Giving it the extra stamina to meet the unusual load as well as the routine one . . . to give extra service where extra service is called for. Bringing it to the high standards it must pass, to carry the Roebling Trademark . . ."

JR ROEBLING

Roebling Research, Roebling Engineering, Roebling Plant Facilities and broad Experience . . . each adds its part to the extra values in Roebling "Blue Center" Rope. Each helps it meet conditions unfailingly, wherever wire rope has a routine or unusual job to do.

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Distributed by THE NATIONAL SUPPLY COMPANY

THAT'S THE ONLY WAY TO MAKE

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"Blue Center"

STEEL WIRE ROPE

PREFORMED OR NON-PREFORMED

P 420.5
P 422.

Present Position of the Drilling Contractor*

Drilling costs, life of equipment, and future outlook for the contractor among topics discussed

by Brad Mills

Executive Secretary, American Association of Oilwell Drilling Contractors

THE drilling of oil and gas wells by contract is as old as the oil industry itself. The famous Drake well in Pennsylvania was drilled in 1859 by William Smith and his two sons, working under contract. Colonel Drake contacted several contractors who had been drilling salt-water wells in the area before he successfully engaged Smith under contract to drill deeper in search for oil. The Drake well, first commercial oil producer in the United States, was completed at a depth of 69 ft., and was regarded at the time as a very hazardous undertaking.

During the intense activity that followed completion of the Drake well in 1859, most of the drilling was done by contractors. The scramble to complete wells over an expanding area in Pennsylvania and other eastern states during the period 1860-80 led to development both by producing companies and drilling contractors. Many drillers who had worked successfully for producing companies recognized the possibility afforded by the contracting angle, and soon offered their services to oil interests on this basis. A shortage of highly skilled labor existed for a time, and the reliable cable-tool contractor was kept busy until a serious slump was precipitated by the first over-production period about 1870.

From the very beginning, many producing companies believed they could drill their own wells better than the contractor could drill them. Contractors succeeded in breaking down this resistance in every major producing area, but only after much effort in several places. California was one of the last large producing areas to adopt contract drilling on a major scale, although during the early development periods in that state the drilling contractor was a prominent factor. Many companies there that did almost all of their own drilling between 1910 and 1932 are now having a good part of th- urilling done by contractors.

Drilling contractors annually complete more than 75 percent of all wells drilled in the United States. There are approximately 2500 drilling contractors in this country, and this surprising total includes organizations equipped to meet every drilling requirement. They normally employ between 75,000 and 100,000 persons, and actually support several times that number. Between 4000 and 4500 rotary drilling rigs, and between 2800 and 3200 cable-tool drilling rigs are available for immediate use in the United States, and of these totals drilling contractors own and operate about 75 percent.

*Paper presented before recent meeting of Petroleum Engineers Club, Dallas, Texas.

BRAD MILLS

was made executive secretary of the American Association of Oilwell Drilling Contractors in March, 1941—For 16 years previously he had been associate editor of *The Oil Weekly*—Makes his headquarters in Dallas, Texas.

Cost of Drilling Rigs

A very light-weight rotary drilling outfit costs about $25,000; a medium weight rotary drilling outfit approximately $60,000; a very heavy type steam drilling rig as much as $125,000; a gasoline or butane rig about $140,000, and a heavy Diesel-electric rig represents an outlay of almost $200,000. Cable-tool drilling rigs cost from $7,500 to $25,000; but they are as essential to maintenance of oil reserves as rotary tools. These values represent original cost, and should not be regarded as the present worth. All drilling equipment depreciates rapidly, and replacements are numerous.

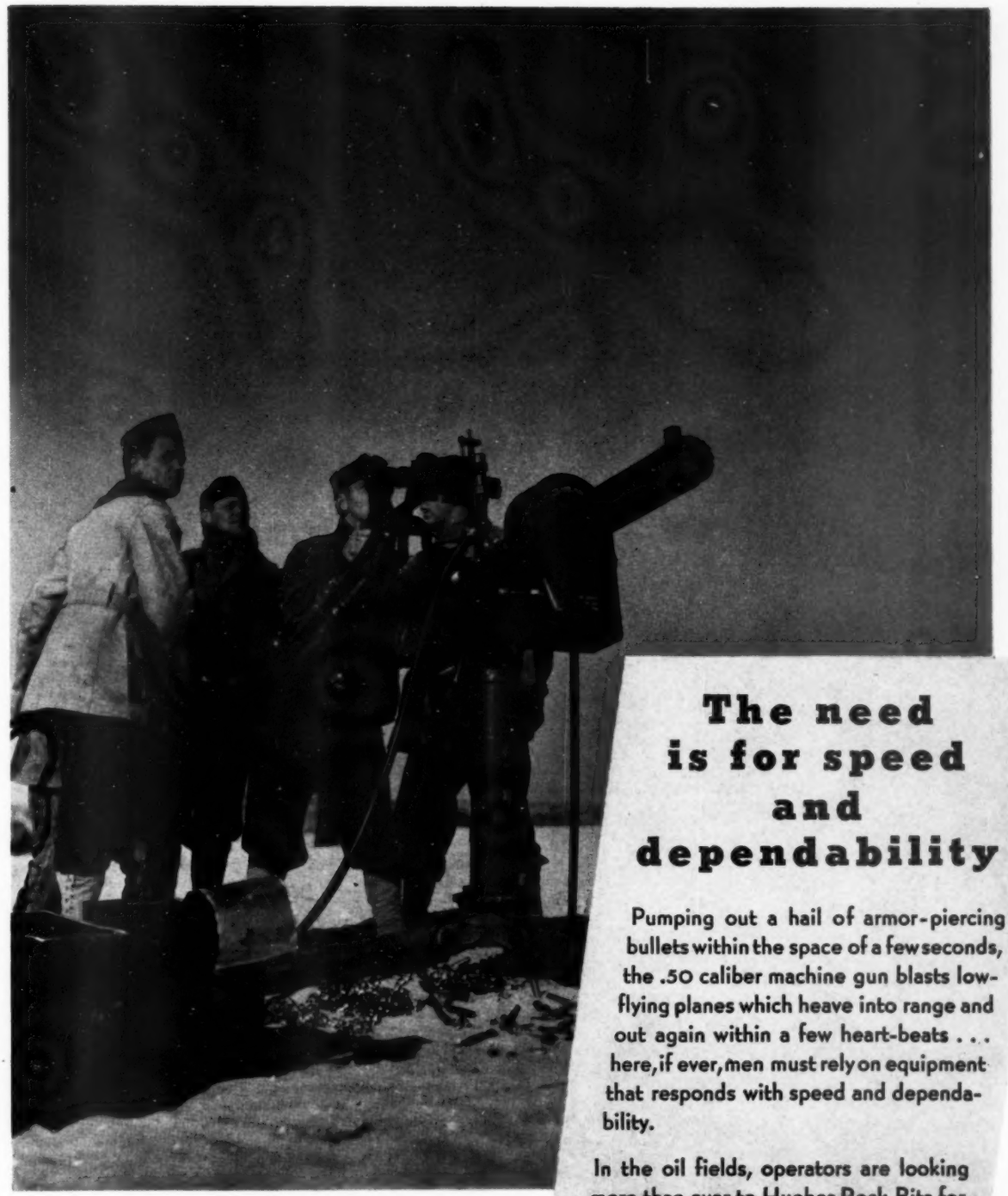
The rotary drilling contractor with 5 active rigs steadily employs from 70 to 90 persons. Some of the largest drilling contractors each employ as many as 400 skilled workers. These crews are trained and coördinated over a long period, and every contractor is reluctant to disband an efficient crew when activity declines. The drilling contractor's desire to keep busy is not altogether a selfish one. His crews are built-up and trained over a long period of time, and every contractor feels a sense of responsibility to his men. Drilling crews draw high wages, but they average working only from 7 to 10 months per year. If forced to curtail operations to an absolute minimum for a considerable period, skilled drilling employees would probably seek work in other lines. If such a development should occur, and the need should arise later for intense field activity to develop new oil reserves, the drilling contractor could easily have trouble in assembling competent crews to carry out necessary drilling.

Available drilling equipment in the United States probably is adequate for carrying on normal drilling operations for some time, with the exception of repair stocks. With the government trying to conserve vital materials of all kinds, it seems possible there can be some type of distribution or division that will put into service drilling tools already available. During ordinary times it would be a case of every contractor for himself and the equipment companies for all, but during the present emergency the use of drilling tools now available should come first.

The equipment manufacturers also are anxious to keep their organizations intact, and they certainly deserve consideration in any plan that discontinues or sharply curtails plant operations. To discontinue the output of major equipment items might prove a dangerous precedent in case of a long war.

Life of Drilling Rig

The service life of a drilling rig is difficult to determine as a single unit. Many of the major items last several years, whereas other items wear out in a short time. Frequent replacements obviously will be necessary to carry on normal drilling operations in any area. The average service life of a drilling

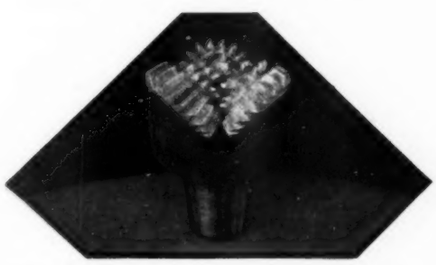


U. S. Army .50 Caliber Anti-aircraft Gun

The need is for speed and dependability

Pumping out a hail of armor-piercing bullets within the space of a few seconds, the .50 caliber machine gun blasts low-flying planes which heave into range and out again within a few heart-beats . . . here, if ever, men must rely on equipment that responds with speed and dependability.

In the oil fields, operators are looking more than ever to Hughes Rock Bits for drilling faster, straighter, full-gage hole . . . the urgency of the times and the critical need for oil to feed an expanding armed force has placed a new emphasis on speed and dependability in drilling.



Hughes Tool Co., Houston, Texas

outfit is four or five years when based on normal rates of depreciation. This means that whereas some of the items must be replaced several times in four or five years, other parts will remain serviceable throughout the entire depreciation period. Such items as wire line, bits, and drill pipe are not ordinarily depreciated as much on a time basis as on a service basis. Equipment receiving fairly uniform service lasts longest and usually is depreciated on a time basis. Boilers, derricks, pumps, engines, and drawworks have a comparatively long service life.

Drilling Contractor's Position

Developments since December 1, 1941, have considerably changed the drilling contractor's position. We are no longer operating under normal conditions and we know every industry will have to make substantial sacrifices to win this war. From its highly preferred position of last fall, when more than 30,000 wells were planned for 1942, the drilling industry has been forced to accept a far more modest program for this year. It has had to give up the idea of "business as usual," but this does not mean that a large number of wells should and will not be drilled this year. Last year we drilled more than 31,000 wells, but this year we are unable to give a satisfactory forecast of probable activity. Estimates on the number of wells to be drilled in 1942 run from 10,000 to 20,000. It is possible only 10,000 to 12,000 will be drilled, but increased activity during the second six months of this year may change the picture and bring the total number of wells completed sharply upward. The average of several estimates is about 16,000 wells for 1942, but recently the OPC stated that 19,600 wells should be drilled to insure adequate future reserves.

In another 18 months the United States may be forced to supply nearly all oil requirements for the Allied Nations. Already some of the large oil-producing areas have been shut-off by Axis activity.

Drilling contractors throughout the United States have been severely affected by recent curtailment of field operations. We do not know how long this condition will last, but feel that the pendulum will swing the other way as petroleum requirements are increased by war demands. Consumption of petroleum products by automobiles may be the governing factor in future demands.

Drilling Costs

The cost of drilling and equipping a well in the United States varies from $1000 in the very shallow districts to $200,000 in the deepest producing areas. The average drilling cost for the United States is about $21,000 per well. The cost per foot varies from $1.50 to $15.00. The average drilling cost in the United States is about $7.00 per foot, including materials necessary to place the well on production.

The drilling contractor performs his work almost exclusively on a footage contract basis. Wells are seldom completed on a "so much per well" basis, and the rule is to charge the same amount per foot from top to bottom for a completed hole.

The early day contractor was chiefly concerned in making hole, and knew little of the technical aspects of his work. Today the large contracting firms employ petroleum engineers and geologists who are as familiar with formations and physical requirements as are the personnel of the largest producing companies.

The total drilling cost of an oil well is divided into three principal classifications. They are labor, equipment, and expense. The proportions of each varies in the several districts, and also under changing conditions. A good average breakdown of costs shows labor to be about 33 percent, equipment 45 percent, and expense 22 percent.

The government is strongly encouraging the drilling of more wildcat wells than ever before. The cost of drilling such wells is always much higher than the average for subsequent wells drilled after discovery. Less than one wildcat well in each 50 drilled discovers a new oil field in some of the producing areas, but this ratio has been reduced to about 1 oil discovery to each 10 wildcat wells in one or two districts. In the Gulf Coast, where formations are fairly regular and geophysical work is advanced, wildcat failures are fewer than in such areas as the Rocky Mountains and Oklahoma.

When the American Association of Oilwell Drilling Contractors was attempting to reach an agreement with the Wage and Hour Division last summer, Washington officials were much impressed with wages paid by the drilling industry. When one of our committee members remarked that his truck drivers had been earning about $225.00 per month, one of the assistants in the Division remarked that he had never heard of such a wage for a truck driver. They were equally impressed by the $18.00 per day a driller was earning during an over-time day. It was largely because of these high wages that we were able to reach such a satisfactory agreement with the Division.

Function of Drilling Contractor

The primary function of the drilling contractor is to complete work required by the operator in a manner and at a cost in line with that of the operator if he ran his own tools.

The relationship of the contractor to the operator is substantially that of the employee to the employer.

The average drilling contractor in the past has kept inadequate records. He has not been able to determine such items as depreciation, obsolescence, overhead, and supervision. Many contractors have drilled themselves out of business by failure to recognize the importance of depreciation. The contractor who wears out his tools while "breaking even" on current items soon finds himself without tools and without money to buy new ones.

In the early days of drilling it was essential that the contractor keep in the good graces of the oil company superintendent. Occasionally a major oil company superintendent would force the contractor to move 10 or 15 miles to a new location, then would move in another contractor to drill an off-set to the well just finished by the previous contractor. Usually this was done only as discipline for some error on the contractor's part, but it was in the power of the superintendent to do this if he so wished.

Written contracts were rare until about 1900, and verbal contracts are still widely used in many producing areas. The written contract now is the standard in all rotary-drilling areas. These contracts vary with conditions and the moods of the operators. Where one oil company will require the contractor to assume certain hazards, other oil companies in the same area may not do so.

Rotary Tools First Used at Spindletop

Rotary drilling tools first were used for oil-well drilling in the Spindletop field about 1901. This type of hole-making had been applied to water-well drilling several years before. It was so different in principle that many drilling contractors were slow to see its possibilities. Several small wars broke out between rotary-tool and cable-tool proponents, but in the end the type of tools best adapted to a given area won the verdict. Both methods still have definite places in the drilling industry, yet each has its limitations.

Drilling contractors everywhere are making substantial sacrifices to meet changed conditions. They are hopeful that activity will continue at a rate that will permit them to keep their organizations intact for increased work that must follow. This is about all they ask. ——☆☆☆——

BAASH ROSS News

PETROLEUM ENGINEER EDITION

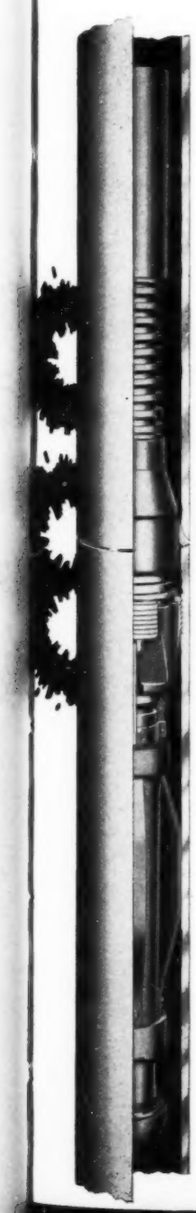
BAASH-ROSS TOOL COMPANY, LOS ANGELES, HOUSTON, NEW YORK

A BULLETIN COVERING NEWS OF EQUIPMENT AND OPERATIONS IN THE PETROLEUM INDUSTRY

Salvage Work { THESE TWO TOOLS OFFER OPERATORS IMPORTANT ADVANTAGES IN MODERN SALVAGE OPERATIONS

Recovering Pipe From Old Wells Requires Equipment That Insures Minimum Damage

Today, with casing tubing and other equipment at a premium, salvage operations on old or abandoned wells are becoming increasingly important. Thousands of extra feet of usable pipe are thus being recovered by operators for use in their current development programs.



But in undertaking these operations there is an important point to remember...that in such salvage work, the generally weakened condition of the pipe being recovered makes the design and operating efficiency of the tools you use of even greater importance than ordinarily might be the case. Here it is *doubly* important

'Cushioned' FEED

that as little unnecessary strain as possible be put on the

KNIVES

SUPPORT

pipe... that the cut and recovery be made smoothly, quickly and efficiently without damage to the pipe and without risk of freezing the tools.

And there is an important reason why operators doing this type of work find that they get the job done better, faster—*at lower cost*—when they make the cut with the Baash-Ross Internal Casing Cutter and then recover the pipe with the Baash-Ross Rotary Releasing Spear...for these two tools embody certain engineering advantages that make them ideal for salvage operation use.

For example, notice in the Baash-Ross Casing Cutter how close the knives are to the anchoring slips. They are separated by only a few inches, whereas in many cutters the knives and slips are separated by as much as several *feet!*

By putting the knives as close to the slips as possible, B-R engineers have achieved more rigid support between tool and casing as the cut is made... thus insuring a faster, *smoother* cutting action and better all-around operating efficiency. This feature is particularly important when recovering pipe that has been pitted by corrosion, for the close-coupled, rigid support prevents chatter and wobble even though the surface is rough and pock-marked where the knives make their cut.

▸ And here's another important point. See the square coil spring on the upper part of the body? Cutting weight is applied to the knives *through* this spring, cushioning out any vibration or roughness in the cutting action and insuring steady even feed at all times. Yet the feed can be instantly increased or decreased to meet changing requirements of the cut by merely regulating the weight!

Contrast this "cushioned" feed with the rough jarring feed that is apt to occur where the bare weight is applied directly to the knives and you see why this tool cuts ALL sizes of casing, tubing or drill pipe with smooth efficiency *regardless of their condition.*

▸ One more time-saving advantage. With this cutter you can make *any* number of cuts on one run... a time and money-saving feature particularly important in salvage operations. If the pipe is stuck and you aren't sure where, you can start low, make a cut—and if this doesn't free you—move up the pipe in stages, making one cut after another until the pipe is freed... *all without coming out of the hole or wasting extra time!*

There are still other advantages built into this tool that will cut the cost of your salvage operations to the bone. Your nearest Baash-Ross representative has the full story and will be glad to show you how they fit into your particular salvage job. Let him help you.

(Leased in U.S.A.—Sold for export only)

FOUR PERFORMANCE POINTS THAT SIMPLIFY PIPE RECOVERY

For salvage work, here's the tool operators have found to be particularly efficient for recovering the pipe after the cut has been made... the **Baash-Ross Rotary Releasing Spear!** ***Why?*** There are four reasons, each of them vitally important...

MORE SLIP AREA

FLAT-BACKED SLIPS

ALIGNMENT COLLAR

▸ First—and most important—the slips are FLAT-backed and operate against a FLAT taper. This is one of the most valuable advancements ever built into a spear for, unlike round-backed slips that operate against a cone shaped taper, *flat*-backed slips are fully supported at all times—*regardless of their working position on the taper.* This eliminates danger of splitting the slips and jamming the tool under the heavy pulling strains encountered in salvage work... and insures *positive release* whenever desired!

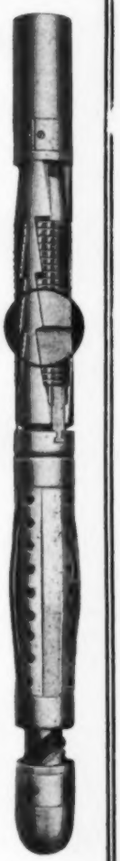
▸ Second—the entire releasing mechanism in this tool is *below the slips—completely out of the way of all jarring and pulling strains.* That's why this Spear is instantly ready to release when necessary... a feature of great importance in all salvage work!

▸ Third—an "alignment collar" holds all of the slips in positive alignment as they grip the pipe, insuring a *uniform* grip that eliminates risk of splitting or damaging the pipe through concentrated slip pressure.

▸ Fourth—the pipe is further protected by the fact that the B-R Releasing Spear has greater effective slip area, reducing the per-unit pressure against the pipe. Not only are the slips *longer* for a better hold *up and down* the pipe, but they are also *wider* for a better grip *around* the pipe!

No matter how heavy the pull, the greater slip area of this Spear coupled with the positive alignment of the slips, insures maximum protection to the pipe you are trying to salvage. Add to this the important safety advantages of the *flat*-backed slips that will not split, nor jam, nor freeze under heavy pulling strains and you see why so many operators insist upon the Baash-Ross Releasing Spear for recovering pipe in all their salvage work!

(Leased in U.S.A.—Sold for export only)



A NEW CAMOUFLAGE PAINT has just been announced for use in concealing fuel storage tanks, refineries and other defense structures and equipment. It is available in seven colors—green, tan, black and four intermediate shades. All seven colors are reported difficult to see from the air and adequately meet the various requirements of good camouflage in any sort of terrain. In spite of the dark colors, the paint has exceptionally high heat-reflecting properties, throwing off most of the sun's rays that would normally be absorbed, it is claimed.

(No. 311)

A RADICALLY NEW TYPE *of luminous paint has recently been developed and is now available for use under "blackout" conditions. Unlike conventional luminous paints made of radio-active materials, this paint is said to be non-poisonous, retains its luminosity over long periods of time and does not require a protective covering. According to reports, it stands up under all types of weather conditions, can be applied to almost any material, including cement, canvas, wood and steel, and can even be immersed under water without damage. At least one large oil company is reported experimenting with it for use in protecting trucks, identifying valves and safety equipment in refineries, etc. Samples are available to companies for experimental purposes.*

(No.312)

BAASH-ROSS

For additional information on these items, send on a post card or letterhead your name, address and key number of items that interest you.

Tentative Program of Natural Gasoline Association of America, Annual Convention, Tulsa, Oklahoma, May 14-15

The tentative program for the 21st Annual Convention of the Natural Gasoline Association of America, to be held at the Mayo Hotel, Tulsa, Oklahoma, May 14 and 15, has been announced as follows:

THURSDAY, MAY 14

10:00 a.m.—Registration

10:00 a.m.—Technical Committee meetings

2:00 p.m.

Gas Testing Committee Report, by H. L. Oder, Cities Service Oil Co., chairman

(Presenting a revised charcoal testing method and recommendations for reclaiming both charcoal and glycerin.)

Technical Committee Report, by H. H. Beeson, Sabine Valley Gasoline Company, chairman

(This report includes the presentation of new standard tables of physical constants for the principal hydrocarbons, a new alternate standard for determining the specific gravity of liquefied petroleum gases by the hydrometer method, and new volume-temperature correction factors for pure liquefied petroleum gases, their mixtures and for natural gasolines.)

"Elimination of Errors in Fractional Distillation of Gases," by H. A. Montgomery, Hanlon-Buchanan, Inc.

(This paper covers the results of two years of committee research in which identical gas samples have been exchanged and analyzed by the laboratories of 15 co-operating companies. Recommendations will be presented for changes in both procedure and apparatus to obtain greater accuracy and duplicability of results.)

"The Testing of High-Pressure Gases," by C. H. Gee, La Gloria Corporation

(A report of the High-Pressure Gas Division Technical Committee covering comparative field tests now being conducted along the Gulf Coast.)

Evening—Entertainment for all registrants, courtesy of the Natural Gasoline Supply Men's Association.

FRIDAY, MAY 15

9:30 a.m.

"A Suggested Standard Method for the Measurement of High-Pressure Gases," by Dr. Donald L. Katz, University of Michigan

(A correlation of all authoritative data on the subject combined with extensive field surveys and presenting specific recommendations for standardizing calculation of deviations from Boyle's Law, high-pressure orifice meter measurement and supercompressibility factors.)

"The Transportation of Light Gasolines in Crude Oil Pipe Lines." Speaker to be announced.

(A general discussion of modern pipeline practice with specific reference to the movement of natural gasolines in crude oil streams.)

"The Extraction of Butane," by J. W. Wilson, Cities Service Oil Company

(This paper will discuss in detail the various methods of obtaining high yields of butane at natural gasoline plants, including technical details, efficiencies, general economics, etc.)

2:00 p.m.

This entire session is to be devoted to discussion of the position of natural gasoline in the war program with specific reference to special products, transportation, priorities, etc. Two authoritative speakers connected with the OPC will discuss the needs, recommendations, and requirements of the war effort and answer questions from the floor regarding any parts of the present organization and procedure.

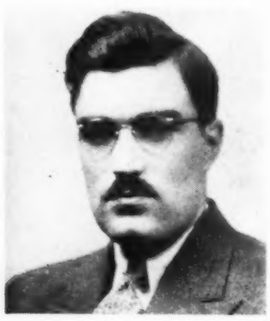
7:00 p.m.

Banquet celebrating the 21st anniversary of the Association.

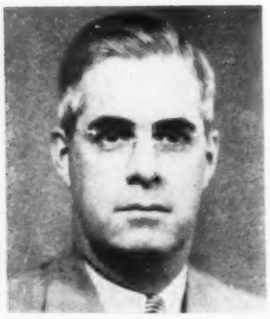
Address—Ray E. Miller, N. G. A. A. president, vice-president, Hanlon-Buchanan, Inc.

Presentation of Hanlon Award. Address by nationally known speaker whose name and subject are to be announced later.

RAY E. MILLER, President



D. L. KATZ will present "A Suggested Standard Method for the Measurement of High-Pressure Gases"



E. O. BENNETT, Chairman, High Pressure Gas Division, Technical Committee

H. A. MONTGOMERY will discuss "Elimination of Errors in Fractional Distillation of Gases"

H. H. BEESON, Chairman, Technical Committee

H. L. ODER, Chairman, Gas Testing Committee

You get long hard service—
money-saving service—when you specify
J&L Permaset
PRE-FORMED
WIRE ROPE

J&L STEEL

JONES & LAUGHLIN STEEL CORPORATION
AMERICAN IRON AND STEEL WORKS
GILMORE WIRE ROPE DIVISION, PITTSBURGH & MUNCY, PENNSYLVANIA

J&L OIL COUNTRY PRODUCTS
SEAMLESS TUBING • CASING • J&L INTEGRAL-JOINT DRILL PIPE
LINE PIPE • WIRE ROPE

J&L—PARTNER IN PRODUCTION TO INDUSTRY AND DEFENSE

Complete Detonation in Well Shooting

Petroleum Engineer Exclusive

☆ **Centralized detonator that affects all parts of explosives pack at proper instant results in uniform blast**

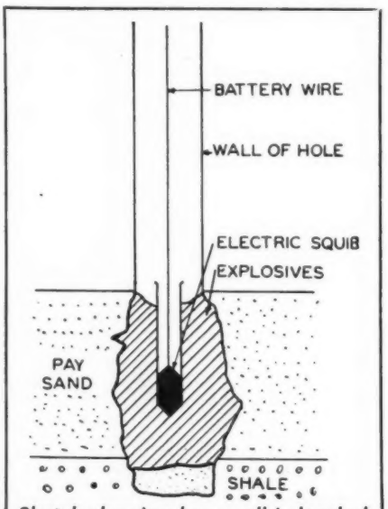
by F. R. Cozzens District Field Manager, Equity Oil and Gas Company

SOLIDIFIED nitroglycerin, commonly termed gelatin, is rapidly gaining prominence as a well torpedo in eastern oil-producing areas. Under certain conditions, its results appear to equal and even to surpass liquid nitroglycerin, as the solidified form, which may be had in various types and strengths, is less sensitive, and can be pressed by a qualified shooter into pockets and crevices of a sand face to give the utmost in blasting efficiency. The correctly loaded shot cracks and crumbles the sand face, exerting equal force in all directions against it, and following, of course, the lines of least resistance. These lines should be the small cracks and porous structure that are a natural condition in a producing sand, thus such cracks are enlarged and amplified.

Solidified nitroglycerin is exploded by the same means as liquid nitroglycerin, and after a well has been loaded with the required amount and type, and the anticipated jar indicates that the detonating agent has found its mark, it is generally supposed that the problem of shooting that particular well is solved.

During the last three years, however, some very interesting research relative to well shooting with solidified explosives has been carried out, and operators have been surprised to learn that less than 15 percent of their favorite "shots" exploded with precision sufficient for most effective results, and in more than 70 percent of the cases unexploded particles of the charge were blown into the residue and wasted. Partial detonation, which is now recognized as a major problem in well shooting, is wasteful of explosive materials, dangerous to workers and equipment, and is the principal reason why many promising wells fail to give desired production after being shot.

Partial detonation seldom is the result of defective explosive materials. Barring common accidents, such as caving, misplacement of charge, etc., the trouble almost invariably has been with the detonating agent and is due to the fact that the force of compression is speedier than the explosive's ignition at the time and point of detonation. Under great compression, the solidified materials do not explode. Practically all detonating agents, with the exception of the time-bomb, which is not generally used, expend their force at the extreme top of the explosives pack. This point of detonation gives every opportunity for compression of the center and lower masses of the charge, where, if detonation does occur, unexploded particles are almost certain to be blown into the spoil or residue that is being forced from the well. The smaller the diameter of the well, the more likely this is to occur. Tests conducted under actual oil-field conditions have proved conclusively that the most effective results are attained when the detonating agent contacts the center of the explosives pack, as well as its top and bottom. In wells 4 in. or less in diameter at the bottom, when a torpedo shell is used to house the explosives, electric blasting caps should be attached to the firing wire at intervals of 2 ft. along the entire course of the torpedo.



Sketch showing how well is loaded

Fully 90 percent of newly drilled oil wells can be reamed at the bottom to accommodate any desired amount of solidified explosives, and the majority of operators now use this method. The well is drilled through the producing sand, and in that part of the sand face to be shot the operator anchors 10 to 30 lb. of low-test gelatin, about 40 percent strength, and explodes it by blasting cap and battery. After the residue in the chamber thus formed has been bailed out the main "shot" of solidified nitroglycerin (100 to 500 lb., 100 percent strength) is brought on the job. A metal dump-shell with trap door in the bottom, is filled with the cartridges of explosives, either the 4 in. by 16 in. size, or the 1¼ in. by 8 in. size, and sent to the bottom and dumped. This process is repeated until the entire charge has been loaded and tamped down.

Some operators prefer not to make a chamber for explosives. The cartridges are loaded, end to end, in a torpedo shell, and electric blasting caps are inserted into the cartridges at intervals down the shell. The torpedo shell comes to rest on the cement floor, or it may be "hung" or suspended from the derrick floor by means of wire that holds it against the area of sand to be shot. A wooden tamping stick, a little smaller in diameter than that of the hole at the chamber top, and preferably with lead core for additional weight, is next lowered upon the pack of explosives pressing the mass into all sections, fissures, and crevices of the chamber. The tamping stick is withdrawn, and after being thoroughly cleaned of residue by the shooter, the stick is tapered to a point at its bottom end and again lowered by the sand line until it stops on top of the explosives pack. Tension on the line is slackened gradually to allow the pointed end of the stick to penetrate the semi-solid pack almost to the bottom. When the tamping stick has been withdrawn this time, an electric squib, into which has been taped two No. 8-size electric blasting caps, is lowered on an insulated lead-wire into the opening made by the tamping stick. Electric squibs are obtainable in various sizes to suit any type of well. After careful measurements have shown that the squib is seated snugly in the explosives, the attached lead-wire is drawn taut to prevent buckling, and the necessary amount of weight, or anchor (sand or water), is placed over the charge. It is then exploded, subject to the operator's desire, either by blasting machine or battery.

When this method is used, nature of the residue reveals that the centralized detonator has affected all parts of the explosive pack at the necessary instant, and the blast has been uniform throughout.

☆☆☆

P 629.2
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Hydrocarbon Hydrates*

☆ Conditions conducive to their formation — Methods of removing and preventing

by Ira C. Bechtold

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FOR the last several years, there has been considerable interest throughout the natural gas and natural gasoline industries in the subject of the formation of solid substances by the inter-action of water and hydrocarbon gases. These solids are commonly referred to as "hydrates." It is apparent from the literature and general knowledge of those who are active in the industry that these hydrates have been observed in the field for many years. It is also apparent, however, that in a great many instances the exact nature of these solids was not appreciated.

In years past, when transmission systems were operated at low pressures, the occurrence of hydrates in the field was less frequent than it is under present conditions when relatively high pressures are quite commonly used. During the periods when only low-pressure systems were operated, it was usually necessary that rather low temperatures be reached before hydrates would form and become stable. It was, therefore, often thought that the solids that were found to exist in lines or other apparatus were ice crystals or "snow." In order for this to be true, it would be necessary that temperature in the apparatus under consideration be below the freezing point for water. As the pressure in practicable systems was increased, it was found that the solids appeared at temperatures considerably above 32°F.; in fact, it is quite possible to have natural gas hydrates at temperatures of approximately 50°F. with pressures of about 500 lb. per sq. in. During the last 10 or 12 years, there has been an increasing tendency to study these hydrates and to analyze correctly the difficulties they have caused in the past, as well as to develop means for eliminating them or preventing their formation.

Hydrate Research

Many normally gaseous substances may form hydrates under conditions that are proper for the combination of the gas with water. Such hydrates were knowed as early as 1810 when Davy[1]† showed that chlorine would form a solid with water. Hydrates of saturated hydrocarbons were not studied extensively until about 1888, however, when Villard[2, 3] published a paper consisting of preliminary notes relating to the stability conditions for hydrates of methane and ethane, as well as ethylene and acetylene. All Villard's work, as well as that of investigators who followed him, was of an academic nature and very little, if any, of it was applied to practical commercial operations. DeForcrand and Villard[4, 5, 6, 7] made a number of studies in the early part of this century, and later Schroeder[1] published a rather complete summary of the literature that was available up to 1926. A great many investigators contributed to the literature between Villard's time and the present. Most of these worked in Europe and very little is found in the literature of this country concerning hydrocarbon hydrates until about 10 years ago, when this subject became of commercial interest. Some of the first work in this country related to the problem of hydrates in transmission lines and was published by Hammerschmidt[8] in 1934. This paper covered rather generally the conditions that must exist for hydrates to form, and considerable fundamental technical data concerning natural gas hydrates were presented. Subsequent to this publication, a number of papers appeared that further established the phase equilibria conditions for various natural gas hydrates, so that we now have a very complete background of basic data for the study of hydrates that may form from natural gas hydrocarbons. Deaton and Frost[9], Roberts, Brownscombe, and Howe[10], Wilcox, Katz, and Carson[11], Miller[12], and others have contributed to these general studies. In addition to the collection and analysis of experimental data, there has been considerable attention given to the control of hydrate formation in pipe lines, pressure vessels, instruments, and other equipment. Some of the writers mentioned above have made suggestions concerning such control, and articles have been prepared by others such as Hutchinson[13] and Powell[14] where the principal subject of discussion was the application of fundamental data to hydrate control problems.

Chemical Nature of Hydrates

Throughout the literature, one finds several opinions as to the chemical nature of hydrocarbon hydrates. Many writers have referred to these substances as definite compounds, and in most instances it is assumed that a single molecule of hydrocarbon combines with several molecules of water to form a solid substance that has the properties of a true compound. For example, methane is believed to react with six molecules of water to form the substance $CH_4 \cdot 6H_2O$. To date there is no completely satisfactory theory to account for the existence of these hydrocarbon hydrates. It is clear that compounds of this type could not be formed by ordinary ionic reactions as both substances involved are already saturated and cannot exhibit ionic valences toward each other. Werner's coördination theory[15] as applied to hydrates suggests an explanation that seems quite feasible if we are willing to assume that the necessary "auxiliary valences" can exist. It might also be suggested that the formation of these solids is an adsorption phenomenon and that no true compound formation takes place. Other evidence would, however, seem to make this latter possibility unlikely. Although present theory is inadequate for a full explanation of the nature of these substances, it is expedient and satisfactory to assume that they are addition compounds similar to the hydrates of certain salts.

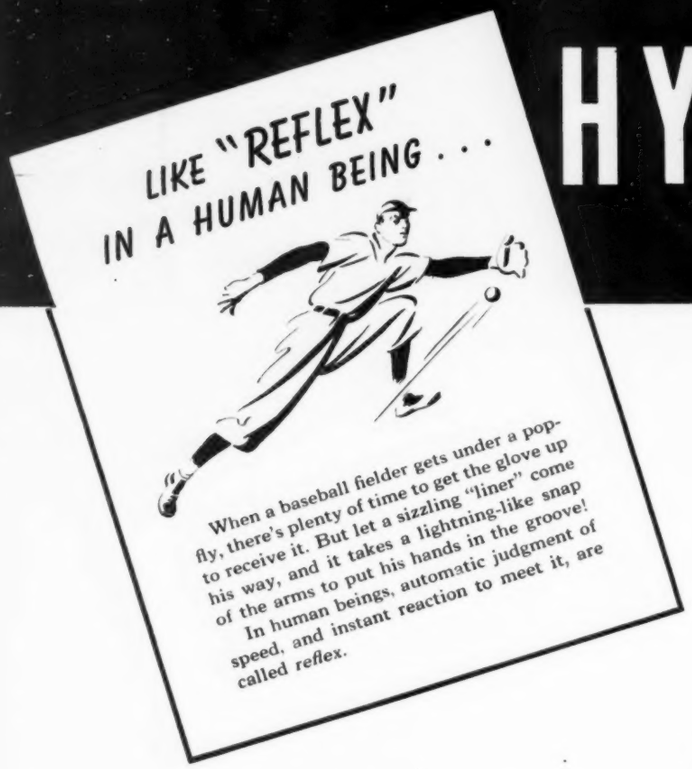
The composition of hydrates of hydrocarbons is not easily determined as

(Continued on Page 60)

*Paper presented before California Natural Gasoline Association, Los Angeles, March 5, 1942.

†Numerals indicate references at the end of this article.

HYPER-RESET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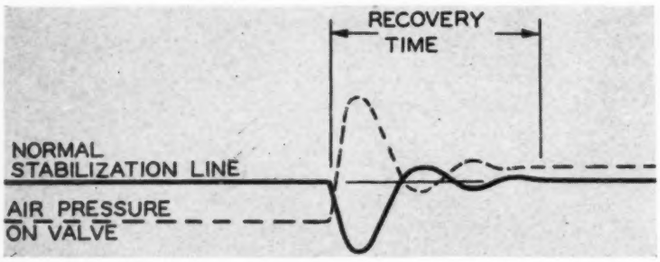
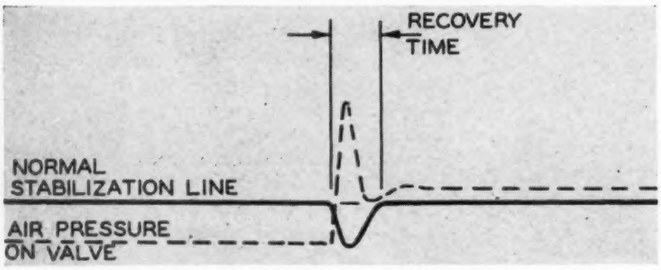


This curve is typical of the results obtainable from good Proportional Control with Reset, before the development of HYPER-RESET. It shows recovery from one arbitrarily-chosen upset.



Here is the recovery curve for the same upset, when HYPER-RESET is added to Proportional Control. Because stabilization is accomplished in *one-fourth* the time, the proportional band can be safely cut in *half*. This is Model 30 Stabilog Control!

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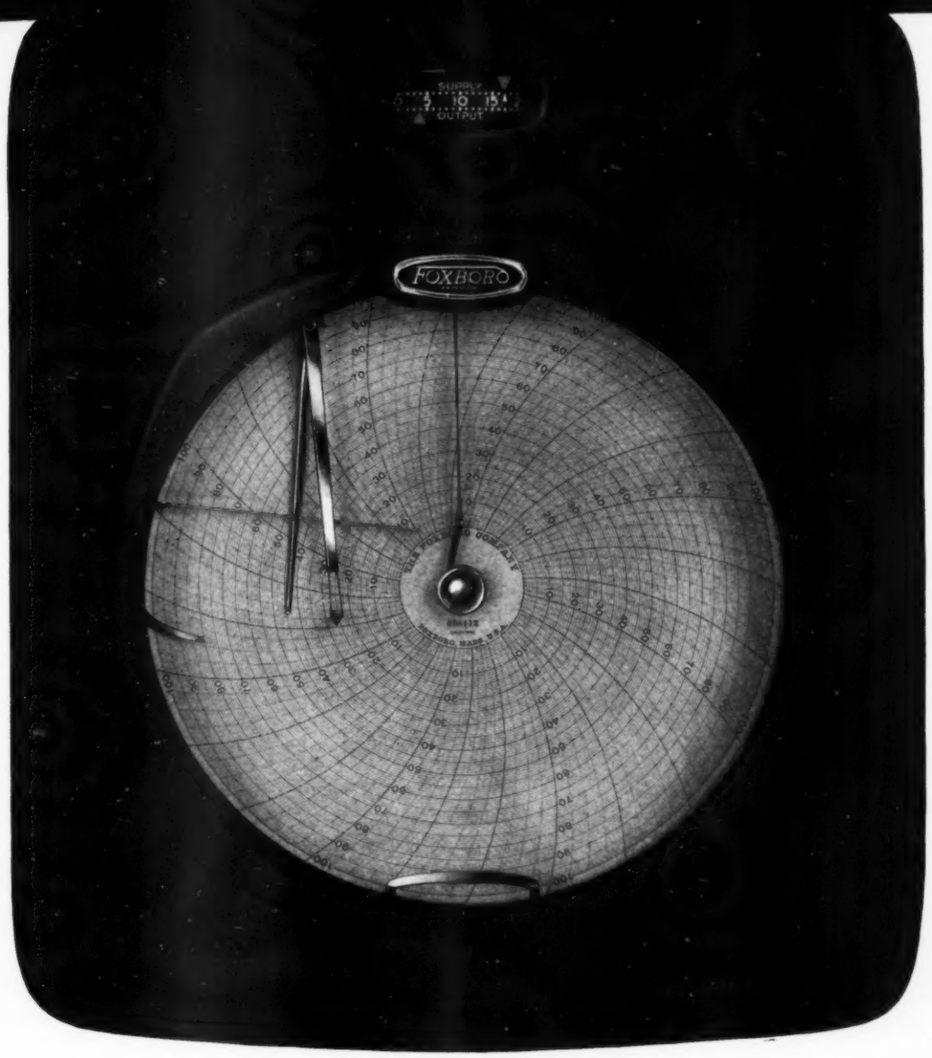

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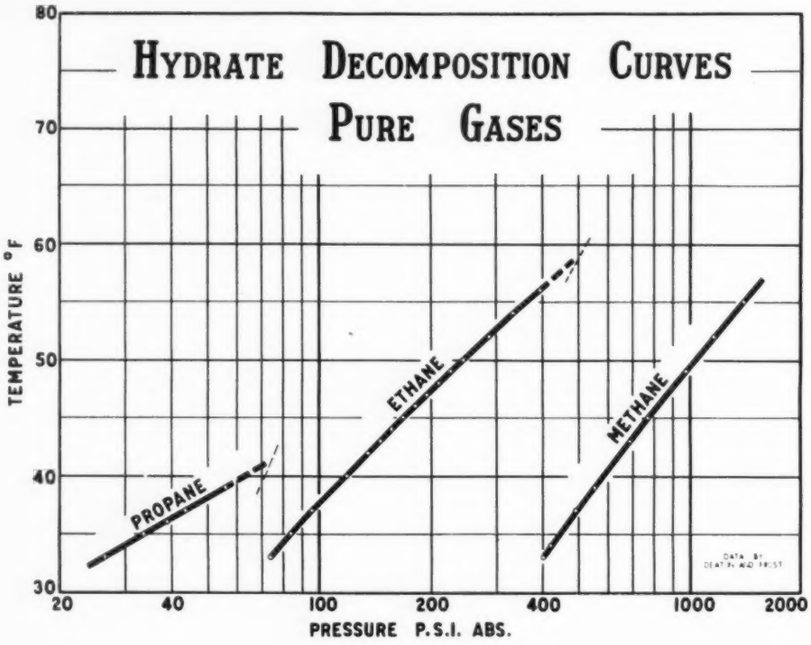

Fig. 1

(Continued from Page 57)

a simple analysis of such substances is not readily accomplished. This is not difficult to understand when it is realized that hydrates are stable only under conditions of relatively high pressures and low temperatures and under all ordinary circumstances they will exist in the presence of unknown amounts of excess vapors and hence cannot be easily isolated for purposes of analysis. One frequently finds considerable disagreement throughout the literature concerning the chemical formula that should be assigned to a particular hydrate. For example, DeForcrand showed that ethane hydrate had the composition $C_2H_6 \cdot 7H_2O$, whereas Hammerschmidt[8] believed the compound to contain six molecules of water, and later Roberts, Brownscombe, and Howe[10] found a value of seven molecules. Schroeder[1] has reported a value of seven molecules. Hammerschmidt[8] developed experimental evidence to show that ethane hydrate contained six molecules of water. Investigations conducted by Villard[16] on gases in general have led this writer to state the following theorem:

> "Dissociable compounds, capable of existing only in the solid state, formed by water with various gases, are isomorphous between themselves, and crystallize in the cubic system, and their composition is expressed by the general formula:
>
> $$M \cdot 6H_2O$$
>
> where M represents one molecule of the gas under consideration."

This viewpoint is in agreement with the conclusions reached by Nikitin[17] and is consistent with the general aspects of hydrate formation as they would be developed from Werner's coordination theory. Although it now appears that there is considerable doubt as to the exact composition of many hydrates of normally gaseous substances, we may assume for purposes of discussion that all the hydrocarbon hydrates contain six molecules of water. Hydrates of ethane, propane, and the butanes have been reported in the literature, and data have been published to show the conditions necessary for their formation. There is considerable doubt as to whether normal butane forms any hydrate; Hammerschmidt[8] could not produce this hydrate at pressures up to 800 lb. per sq. in. To date, it is definitely true that no hydrates of hydrocarbons heavier than butane have been reported.

Hydrate Formation Conditions

The conditions required for the stability of hydrocarbon hydrates are such that one does not encounter these substances frequently under natural circumstances. It is necessary that the hydrocarbon be under super-atmospheric pressure and that a relatively low temperature exist, with conditions so adjusted that a large amount of heat may be removed from the gas at this low temperature. It will be seen from Fig. 1 that the conditions required for hydrate formation will vary depending upon the gas that is being hydrated. These curves represent the equilibrium conditions for the coexistence of the solid hydrates, the vapor phase, and liquid water for the three pure gases, methane, ethane, and propane. At any point along the curve the hydrate may exist in equilibrium with the other two phases. If temperature and pressure conditions are such as to be above the curve, however, only vapor and liquid water may exist; whereas, if they are such as to be below the curve, vapor and hydrate will exist. It will be readily seen that at a given temperature methane requires a much higher pressure for the production of a hydrate than do ethane or propane. In fact, propane will form its hydrate very readily at temperatures well above the freezing point and at pressures of approximately 50 lb. per sq. in. This figure indicates that hydrates are more readily formed as the molecular weight of the hydrocarbon increases. This is true from methane through propane. Data for *iso*butane, however, are not definite enough to establish the position of its curve. When these gases are present in mixtures, of course, the position of the equilibrium curve depends upon the composition. Fig. 2 shows curves for three natural gases having different compositions, especially with respect to propane content. It will be seen from Table 1 that gas "B" is a relatively wet gas, whereas gas "C" has very little propane present, and the fractions heavier than propane are absent. Gas "D" is of intermediate composition. Referring again to the equilibrium curves, we find that their positions are consistent with the analyses previously mentioned. Gas "B" will form a hydrate most readily; that is to say, at a given pressure it will form a hydrate at a higher temperature than the other two gases, or at a given temperature it will form the solid at a lower pressure than is possible with the others. Gas "B" has the lowest methane content and highest ethane and propane content of the three gases. Table 2 shows the data from which these curves were plotted.

Until recently, very little effort has been directed toward a study of the nature of such mixtures of hydrates as must appear when natural gases form these solids with water. Carson and Katz[18] have conducted experiments that indicate that mixtures of hydrocarbon gases form hydrates that are solid solutions and hence the solid mixture produced is but one phase. Nikitin[17] has indicated that mixtures of gases form hydrates that are mixed crystals. The work of Villard has indicated that gas hydrates of most gases should be isomorphous and hence they would be expected to form solid solutions in accordance with the views of Carson and Katz. In the absence of better information, it seems feasible to

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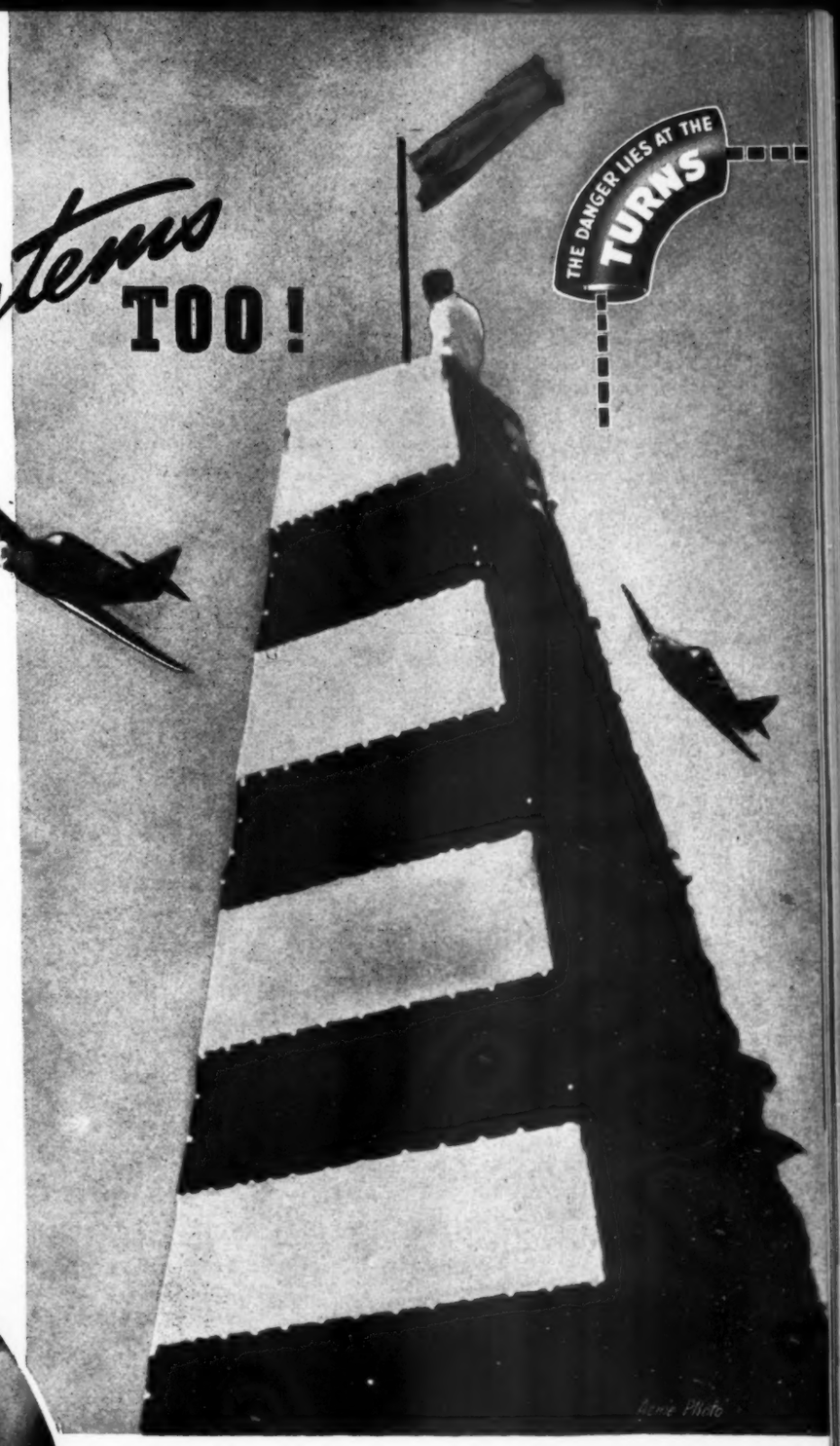

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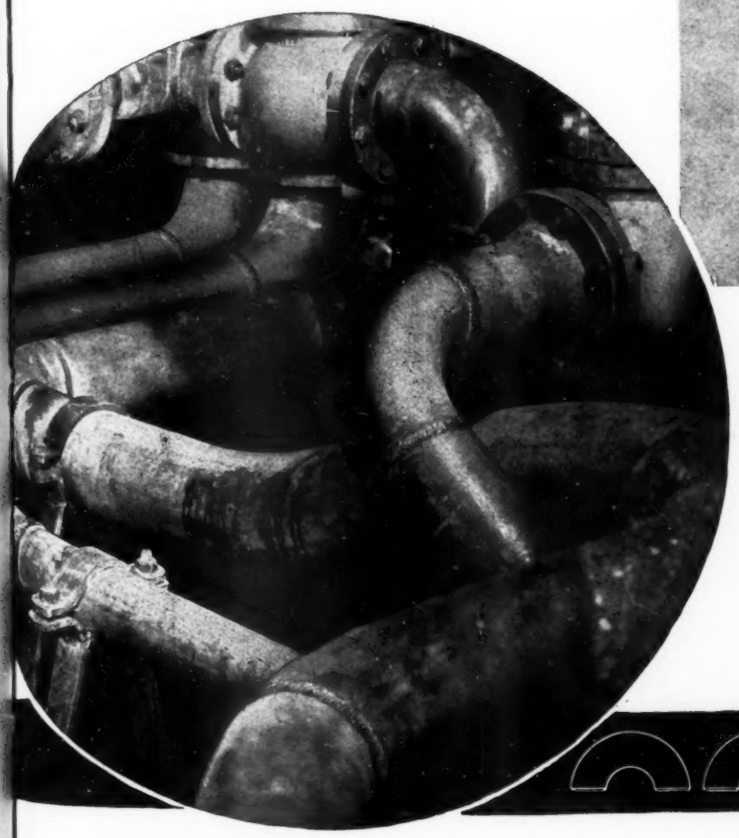

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adopt the viewpoint of Carson and Katz and to use their data, which will allow at least an approximate caluculation of the conditions necessary for hydrate formation when the composition of the gas is known.

The foregoing information makes it possible to determine the conditions necessary for hydrate formation in commercial apparatus such as pipe lines, pressure vessels, and plant equipment. The three primary conditions that must be fixed in order that hydrates will be formed from a gas are as follows: (1) temperature, (2) pressure, and (3) composition.

The composition of the gas determines the position of the equilibrium curve with respect to pressure and temperature. For a given temperature we must always have no less than the equilibrium pressure in order that hydrates may exist. In connection with composition, it may be added that it is always necessary that the gas be saturated with respect to water vapor at the equilibrium point before hydrate crystals will appear. Although the primary conditions may be proper for hydrate formation, it is not always true that the solid will immediately appear. These gas-water mixtures have a tendency to exist for long periods of time under metastable conditions. Certain secondary effects play a large part in determining whether these solids will appear under field conditions. For example, high velocities, turbulence, pulsations from compressors, sharp bends, and similar conditions, which readily promote a mixing action, will augment the formation of the solid phase. On the other hand, conditions that result in low velocities and little turbulence may allow gases to exist without the formation of a solid phase even though the three primary conditions may be in proper relationship for hydrate formation. Once the solid has formed, or has begun to form, it will proceed very rapidly under proper conditions because of the "seeding" effect of the crystals that have developed.

TABLE I
Analyses of natural gases

Compound	Mole Fractions		
	Gas B	Gas C	Gas D
Nitrogen	0.0064	0.0043	.....
CO_2	.....	0.0051	.....
Methane	0.8641	0.9320	0.8836*
Ethane	0.0647	0.0425	0.0682
Propane	0.0357	0.0161	0.0254
Isobutane	0.0099	.....	0.0038
n-Butane	0.0114	.....	0.0089
Pentanes plus	0.0078	.....	0.0101

*Includes nitrogen.

Data by Wilcox, Carson, and Katz.

In order better to understand the conditions under which hydrates form in the field, we may give consideration to a typical example such as might be found in a pipe line. If the gas flowing in this line is of the composition of gas "B" in Fig. 2, and has a water content such that it would be at a dew point with respect to water at any temperature and pressure along the equilibrium curve for this gas, we would find that hydrates could form whenever such conditions existed. For example, if this gas is maintained at a pressure of 300 lb. per sq. in., hydrates would begin forming at a temperature of 50°F. At higher pressures, near 1000 lb. per sq. in., hydrates might be formed at temperatures of approximately 66°F. Of course, it is to be assumed that conditions are such as to allow the heat of formation of the hydrates to be conducted away from the pipe line and removed from the system. These temperatures are high enough to be encountered under normal atmospheric conditions in practically every part of the United States. If the transmission line contains liquid water as well as the water vapor that saturates the gas, it is possible to form a much larger quantity of hydrates than might be the case if the only water present was that in the vapor phase.

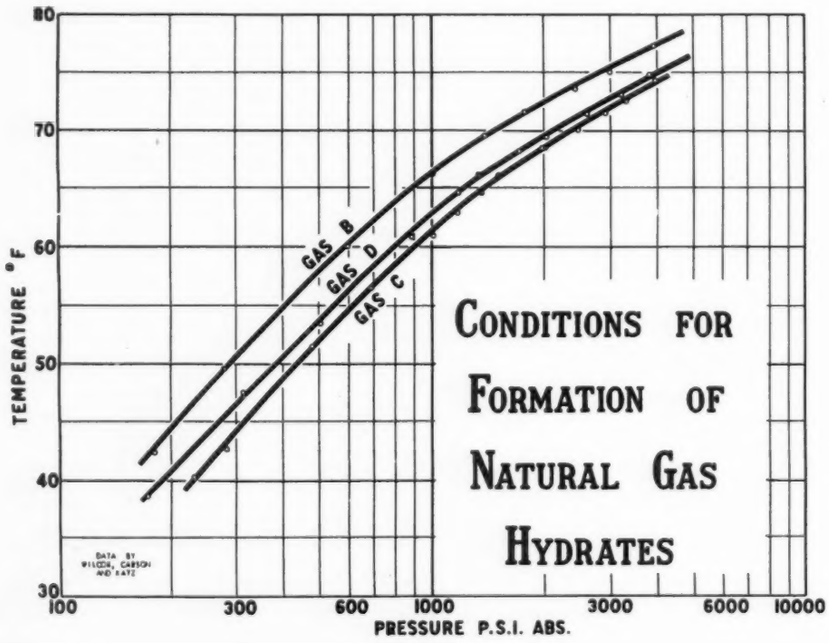
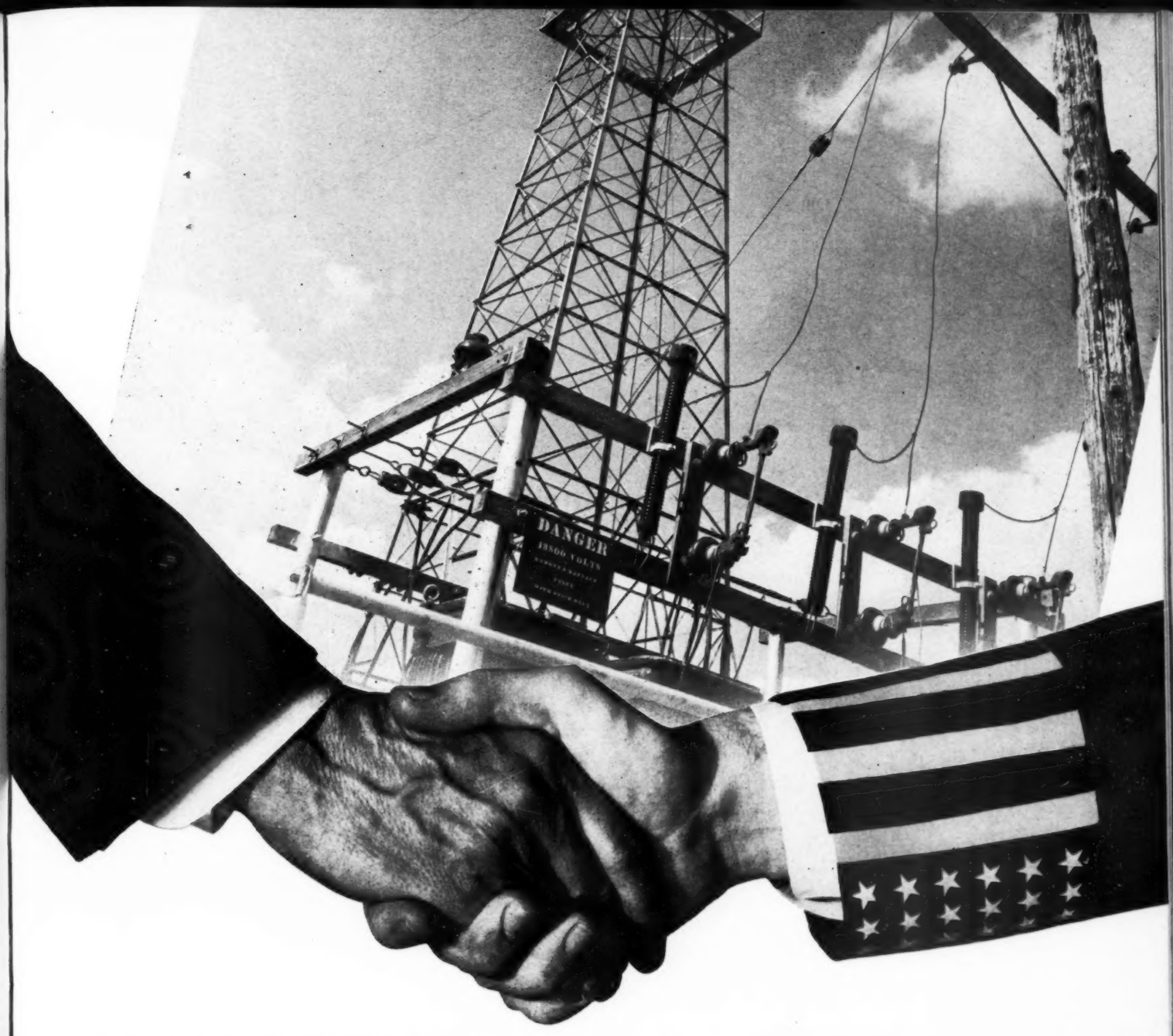


Fig. 2

Hydrate Control

It is of considerable interest to operators to have some knowledge of possible means for eliminating hydrates if they should form in lines or plant equipment, and most important it is necessary to know how to prevent their formation under all conditions of operation. Several writers have devoted papers to this phase of the subject in the past.[19,20,21,22,23,24,25] We may consider the problem of hydrate control to be divided into two categories. First, there is the problem of eliminating hydrates that have already formed and which must be removed in order to restore the equipment to proper operating conditions. Such situations usually arise because gas is handled at high pressures and relatively low temperatures without preliminary dehydration. From the curves of Fig. 2, it is obvious that one simple method for removal of hydrates is to lower the pressure in the system so that it is below the equilibrium point and the hydrate will decompose into hydrocarbon gas and water. This is not always possible, however, as frequently it is necessary to maintain pressure above the equilibrium point for other reasons. Furthermore, it is sometimes possible to lower the pressure to accommodate a given temperature condition at one point and find that the temperature is low enough at another point in the system so that the new pressure is sufficient to produce hydrates at that point. Another obvious expedient would be to raise the temperature at the point where hydrates exist. This has been attempted in some instances by building fires around lines to raise the temperature to the point where hydrates can no longer exist. This is an unsatisfactory procedure because the temperature of the entire system can never be raised sufficiently to preclude the re-formation of hydrates at another point beyond where the decomposition has been effected. Furthermore, this practice is



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dangerous for reasons that are obvious. It is clear that removal of liquid water from equipment does not obviate the possibility of hydrate formation as gas that is saturated with water vapor can deposit hydrates in at least small amounts under proper temperature and pressure conditions. Removal of the liquid water can merely reduce the total amount of hydrate that might eventually be formed. It has been found that when equipment becomes plugged with accumulations of hydrates it is possible to cause their decomposition by the introduction of substances that have a lowering effect upon the decomposition temperature. For example, methyl, ethyl, or propyl alcohols may be added in very small amounts to the gas line or other equipment and the solid hydrate will be found to decompose into hydrocarbon gas and liquid water. It has also been demonstrated that gaseous ammonia will serve the same purpose.[24, 25] The use of ammonia gas when carbon dioxide is present may result in conditions that are even worse than the development of the hydrate plug. Ammonia can form solid ammonium carbonate with any CO_2 that is present and this will accumulate at points in the system where deposition is possible, producing a plug that is not readily removed. It is not possible to decompose this compound by depressuring or increasing temperature in a manner similar to that which may be used with hydrates. It has been reported that fuel oils have been used to decompose hydrate plugs in pipe lines but it is believed that the value of this material for such a purpose is extremely doubtful. Probably the only result that might be produced is one of purely physical removal of the solid substance.

Prevention of Hydrates

So far we have discussed only methods of alleviating a condition where hydrates already exist. It is of more importance to arrange a gas transmission or processing system so that hydrates cannot be formed under any conditions of operation. To accomplish this, it is necessary to dehydrate the gas so that it will never become saturated with water vapor under any temperature and pressure conditions that it may encounter throughout the system. It is not necessary that all the water be removed from the gas so long as the amount remaining is insufficient to bring the gas to its dew point with respect to water at the lowest temperature to be found in the system. Methods of dehydration that are well known may include such processes as dew point lowering by refrigeration; water removal by absorption in glycol dehydration plants; water removal by contact with solid dehydrating agents such as activated alumina or silica gel; dew point lowering by contacting the gas with calcium chloride or sodium chloride brines; or similar operations. It is also possible to take advantage of the decomposition temperature lowering effect of the chemical agents mentioned above by adding them to the gas flowing in the equipment before hydrates are formed. It is now general practice, however, to preclude the possibility of hydrates forming by using dehydration methods, and these should always be included in systems where hydrate formation is anticipated. It is obvious that the method of dehydration to be selected will depend upon local conditions. In areas where atmospheric temperatures do not reach low levels, it will not be necessary to remove as much water as may be the case in extremely cold climates. Of course, pressure conditions throughout the installation will also be a determining factor in selecting the proper process for maintaining a sufficiently low dew point with respect to water.

It is to be expected that as higher pressures are utilized in plant operations and field installations, such as is now being done in repressuring and cycling systems, the problem of hydrate formation will become more common and more troublesome. This is to be expected because at pressures of approximately 2000 to 3000 lb. per sq. in. the equilibrium temperature may easily be as high as 70°F. In many localities, atmospheric conditions are such as readily to provide necessary removal of heat to form hydrates in considerable quantities if the required amount of water is present in the system.

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TABLE 2

Temperatures and pressures for formation of natural gas hydrates

Gas B		Gas C		Gas D	
Temp., °F.	Pressure, lb./sq. in. abs.	Temp., °F.	Pressure, lb./sq. in. abs.	Temp., °F.	Pressure, lb./sq. in. abs,
		First Series		First Series	
42.2	182	40.2	232	38.5	175
49.5	279	51.3	492	47.2	317
60.0	598	69.8	1010	53.2	510
66.2	1010	66.0	1523	60.0	790
69.6	1404	68.2	2049	64.5	1190
71.5	1779			68.1	1740
73.3	2443	Second Series		Second Series	
75.0	3000				
77.3	3963	42.7	279	60.8	895
		47.6	384	66.0	1350
		56.4	699	69.4	2040
		62.8	1180	71.3	2640
		64.5	1375	74.7	3850
		68.3	1999	73.0	3270
		71.3	2939		
		70.0	2489		
		74.3	3989		
		72.3	3335		

Data by Wilcox, Carson, and Katz.

Pipe Lines—Their Construction And Operation

PART 2 (Concluded)

by G. A. Palmer, Formerly District Manager, Baldwin De La Vergne Sales Corporation

Pipe-Line Communications

EVERY pipe-line system has its own complete system of communications, consisting of the most modern telephone and telegraph facilities. The wires generally follow the pipe-line right-of-way. All movements of oil through the pipe-line system are directed and controlled by an oil dispatcher who is in constant communication by telephone and telegraph with the terminals and the several intermediate pumping stations. Every station checks and reports hourly to the dispatcher on its own movement of oil, the dispatcher then issuing any necessary instructions properly to correlate the oil movement of the several stations to each other. The dispatcher of course gives instructions for a change-over from the movement of one grade of oil to that of another grade. In making such change-overs an interesting problem of the dispatcher is closely to calculate and to follow the movement of the head of this stream of new oil in its progress along the line. This is done by the relationship between the cubical volume or displacement of the line and the rate at which pumping is being carried on. Such calculations are worked out quite precisely, though the results are checked by frequent sampling of the oil in the stream at intermediate or terminal stations at about the time the new stream is due to arrive, and upon such arrival the stream is diverted into a new tank.

Water Slug Separates Shipment

Sometimes, to simplify or doubly insure against any intermixture of the two streams, a slug of water is pumped into the line between them, this water being separated by gravity when the oils have reached their terminals. Generally the velocity of oil through pipe lines is approximately four miles per hour.

The oil dispatcher and the station operating crews are always on the alert for evidence of breaks in the pipe line that might result not only in loss of valuable crude oil but damage to lands, crops, or other property. Such loss also involves fire hazard. These breaks may be detected by a drop in line pressure at the station supplying the oil, particularly if the break is not too far from this station. Evidence of even a small break will eventually be uncovered in the discrepancies that would be reflected between the hourly reports of the pumping and receiving stations involved. When evidence of a break is discovered the dispatcher takes charge and orders the line emptied from both adjacent stations by means of a suction pump, topography not preventing, and an emergency crew is sent out to repair the break before operations are resumed.

A photograph and biographical sketch of the writer can be found on page 124 of the March issue of *The Petroleum Engineer* in connection with Part 1 of this article.

Dependable Power Essential

The requirements of pumping station equipment are dependability, economy of operation, and available service. A pipe-line system may be looked upon as the chain that is no stronger than its weakest link, the pumping units in the several stations representing the links. If the pumping equipment at any one station should fail, the capacity of the entire pipe-line system is curtailed perhaps as much as 30 percent until repairs or replacements can be made. Such curtailment means not only that the refiners may be disappointed in their failure to get their allotted consignment of crude, but that the operating company has lost the revenue that otherwise it would have collected for a full capacity movement.

Too frequently pipe lines cannot make up tomorrow movements that they have missed today. The investment in pipe lines is great, the design generally contemplates 100 percent capacity operation, and the significance of dependable performance of pumping equipment is thus very real. At times when only partial operations are required it is customary to continue the operations throughout the usual 24-hour daily period by reducing the rate of pumping.

Stations may be designed with a single pumping unit of the full capacity of any one line itself, or the total capacity of a line may be divided into two such units, each of approximately half line capacity. In some cases an additional unit over and above the re-

Fig. 6. Diesel engine connected through fire wall to pump

Fig. 7. Laying pipe that already has been welded and wrapped

quired pumping capacity for the system is added as a spare or reserve unit. The general absence of such reserve pumping units is a magnificent testimonial to the reliability of the equipment.

Considering the Diesel-powered pumping station, reciprocating plunger-type pumps operate generally at not more than 50 r.p.m. and are equipped with a built-in speed reducing gear to meet the engine speed, which may be anywhere from 200 to 600 r.p.m. Centrifugals, because of the high operating pressure, generally have been standardized in design for operation at 3600 r.p.m. and their connection with the Diesel engine is always through a separate gear-speed increaser unit. Flexible type driving couplings connect the engine and pump, and the gear unit when used, and allow for a reasonable emergency misalignment. The centrifugal pump and its gear-speed increaser generally are mounted together on a rugged steel subbase doubly to insure permanency of alignment of these high-speed members.

As these pumping units are required to operate throughout quite a wide range of speed to accommodate occasional reduced capacity operations, a close study is made of the dynamic factors of the combined engine, coupling and pump as a unit—including the separate gear unit if used—to determine the existence of annoying or detrimental critical vibrations within the operating range of speed by design modifications. Otherwise operations at the speeds involved are avoided.

Fire a Hazard

An ever-present hazard of station operation is that of fire. Normally a station is as clean and the atmosphere around it as fresh as that of any power plant. Under the high pressures at which the crude oil is being handled, however, even a slight break in a high-pressure line, or the failure of a valve packing or gasketed joints, result in the oil being forced out into the open with much of it in a finely atomized or vapor form. Not only is oil in this condition extremely susceptible to ignition from sparks of any nature or from hot engine exhaust lines, but should these oil vapors reach the opening of the Diesel engine air intake line they would be carried into the engine and, because of their own uncontrolled volume, the engine-driven pumping unit might be caused to overspeed and destroy itself, and perhaps the entire station would be destroyed by fire. For this reason extreme care is taken in the design and construction of the stations to avoid these contingencies.

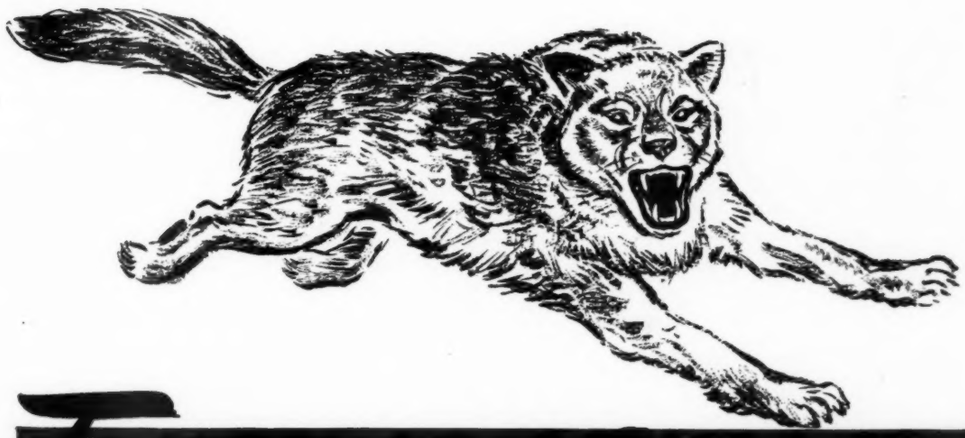
Always, the exhaust lines within the building are covered with heat insulating material and the exhaust line outlets are carried a considerable distance from the building. The air intake lines to the engines also are extended sufficiently out-of-doors to be safe from any escaping oil vapors. Sometimes a partition wall is placed in the pumping powerhouse between the rows of engines on one side and the pumps on the other, thus creating separate engine and pump rooms, each almost hermetically sealed from the other.

That even this latter precaution alone is insufficient to insure against fire, was peculiarly demonstrated a number of years back when a piece of heavy gasket material on a flanged joint of a high-pressure pumping unit broke loose and was driven upward and through the sheet metal roof of the building. The stream of escaping oil following the same path, which incidentally inclined toward the gable of the roof, with the result that this jet of oil then fell back on the other side of the roof and drained off into the intake air supply line of the Diesel pumping unit, which unfortunately was placed just under the eaves. The engine driving the pump thus received a large and uncontrolled volume of crude oil, and not only destroyed itself, but ignited the wild crude oil, and in a short time the entire station was a smoldering ruin. This is merely one of many instances of what may more justly be called innate "cussedness" than fate, where through totally unforeseen and unpredictable circumstances serious destruction of property has occurred.

Another interesting and somewhat parallel instance occurred when a high-pressure pipe connection on the line pump split at its original welded seam or joint. The stream of oil that immediately shot forth happened to be directed against a flanged joint of the engine intake air line. The joint was not perfectly gasketed, and this engine also ran away. Fuel taken into a Diesel engine in this manner is ignited considerably earlier than usual, and although ultimately it acts to overspeed the engine, it momentarily acts to retard it, or cause it to "buck."

In this instance the detailed findings after the engine destruction were peculiar, for the bucking had sheared off all six spokes of the flywheel. The overspeeding ten-ton-flywheel rim then dropped to the floor and ensuing sparks ignited and exploded the oil-filled building. The operator who heroically but vainly had shut off the engine's normal fuel supply found himself blown vigorously but harmlessly some 30 ft. against a wire fence. The shrink joints in the rim of the broken flywheel had been deformed 4 in. from which it is apparent that if the preignitions had not sheared the spokes, the flywheel soon would have exploded from overspeed. Here, again, innate "cussedness" was a major factor, for if the pipe that split at its factory-welded seam had been screwed into its place just 5 deg. more, or 5 deg. less, or to any one of the other 350 deg. positions, the engine would have stopped before the escaping oil could have reached it.

Today Diesel engines in pipe-line



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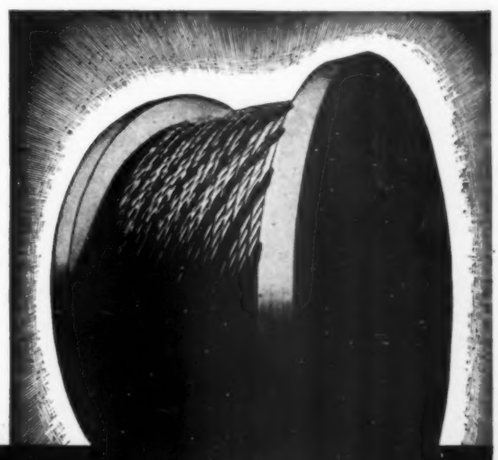

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BETHLEHEM STEEL COMPANY

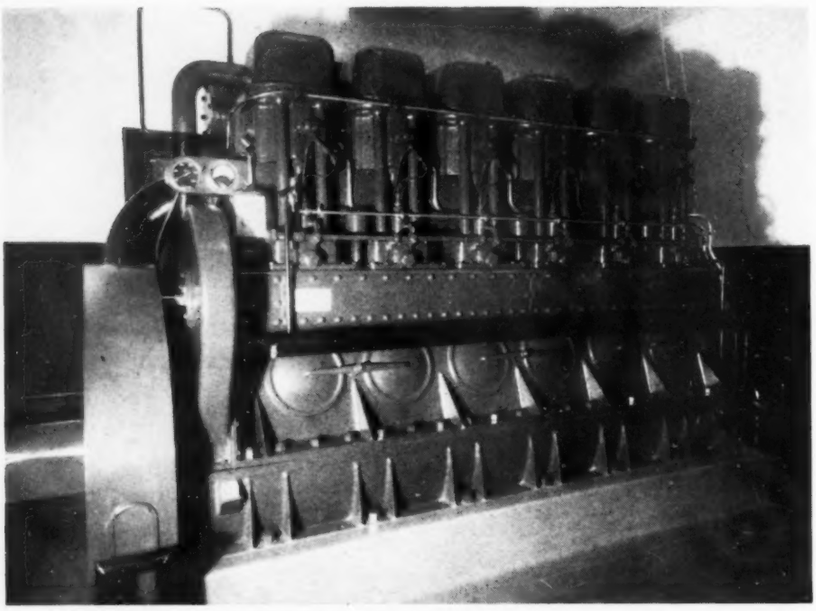

Fig. 8. This 6-cylinder, 485-b.hp. Diesel engine drives an 8-stage centrifugal pump

stations, and in many other cases, are provided with automatic safety devices to shut them down in case they overspeed for any reason whatsoever, by preventing ignition within the engine cylinder of any and all fuel, regardless of its source. The foregoing type of hazard is thus now eliminated, but there still is romance in pipe lining.

Cooling Arrangements

Diesel water jacket cooling arrangements in pipe-line stations are somewhat unusual in that the pipe-line oil itself is used as the secondary cooling fluid. Each unit generally is provided with its own complete and individual cooling system, consisting simply of an elevated surge tank, a shell-and-tube type heat exchanger, a circulating pump, connecting lines, and the usual thermometers, safety alarm, and control devices. The circulating pump may be mounted directly on the engine itself or driven from the engine or the line pump shaft by chain or belt. In pipe-line practice the surge tank frequently is made from a joint of 12- or 16-in. pipe that stands vertically near the engine. Water outlet from the engine is into this nearby surge tank or standpipe, which is provided with the usual vent, gauge glass, etc. The circulating pump takes its suction from the bottom of this tank, and it discharges through the shell of the heat exchanger, from which point the return is to the engine. Crude oil handled by the line pump is passed through the tubes of the heat exchanger. This represents the utmost in simplicity and dependability, for when the pumping unit is started the jacket water pump automatically begins its circulation of jacket water and the oil line pump provides a never-ending supply of fresh, cool crude oil to the heat exchanger.

The advent of this system of jacket cooling in the field of Diesel-driven pipe-line pumping units some ten years ago was one of the outstanding developments of pumping station auxiliary engineering. With such enclosed jacket water-cooling systems no thought need longer be given to incrusting scale, or to the finding of sources of supply of large quantities of water. The chief requirement now is intelligent observation and correction of corrosive tendencies within the jackets and exchangers.

Diesel-driven pumping stations may derive their requirements of auxiliary electric power from local public utility service, if such is available. The station may generate this power itself, usually by a small generator connectable to one or more of the pipe-line pumping units, or it may install a separate small Diesel-electric generating unit. Frequently a combination of the last two arrangements is resorted to, the individual Diesel generating set being used only when the line pumping units might not be in operation.

A Typical Station

Typical of a modern pumping field line station is that of the Continental Pipe Line Company (Fig. 1), located in the south coastal region of Texas, some 75 miles from the Mexican border. Field storage and operating tanks are seen in the background surrounded by a dike or levee in the interest of fire protection. The station office is at the front end of the building. To the back and left of the station, through the Huisache trees, is the manifold with its 12 or more high-pressure gate valves that interconnect between the tanks, the incoming and outgoing lines, and the pump suction and discharge.

Going into the building, we find the single pipe-line pumping unit of this lone prairie station (Fig. 5). In the foreground are centrifugal pump and a gear speed-increaser unit, both mounted on a common cast-iron bedplate. In the background is a Diesel unit, the flywheel of which is enclosed in the sheet metal housing at the near end. Immediately behind the gear speed-increaser unit, in another housing, is a flexible coupling. This coupling was carefully selected for its particular elastic properties, in order to control the location of any objectionable vibrating speeds.

In Fig. 8 can be seen the rectangular governor control panel at the left end of the engine, and nearby the tachometer and the exhaust temperature pyrometer. The carefully housed flywheel in the foreground brings out the fact that all shafting, couplings, and other moving parts of the unit are similarly housed as a safety protection. No organization is more safety-minded today than the oil industry.

The pump embodied in this unit is a size 4-in., 8-stage, centrifugal pump with a rated capacity of 20,000 bbl. per day at a discharge or line pressure of 850 lb. per sq. in. Its operating speed is 3600 r.p.m. The Diesel engine is a 6-cylinder unit with 12½-in. stroke. It is designed for operation at speeds to 625 r.p.m., but for this particular application it is slowed down to a normal maximum speed of 450 r.p.m., at which it is rated 485 b.hp. This reduced rating provides ample power to drive the pump, including a small reserve factor, and the reduced speed of the engine portends a longer operating life and a lower maintenance cost. This particular pipe-line station receives crude from the many surrounding producing areas and pumps it east through the world-famous 1,000,000-acre King Ranch to the Continental Company's terminal at Corpus Christi on the Gulf. The Continental Pipe Line Company unit described might be considered as representative of the medium-speed type Diesel engine as applied to pipe-line pumping.

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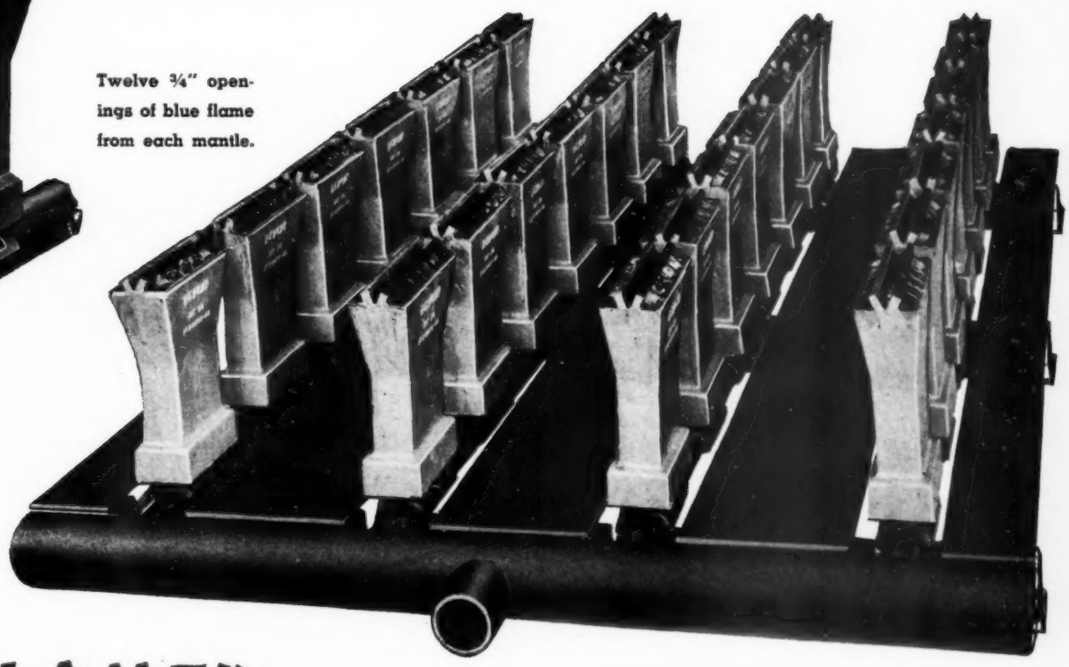

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Usefulness of Sucker Rods Prolonged by Proper Care at the Well

☆ Portable metal stand upon which to lay rods when pulling a well reduces damage to threads and shoulders from dust and sand

by J. C. Albright

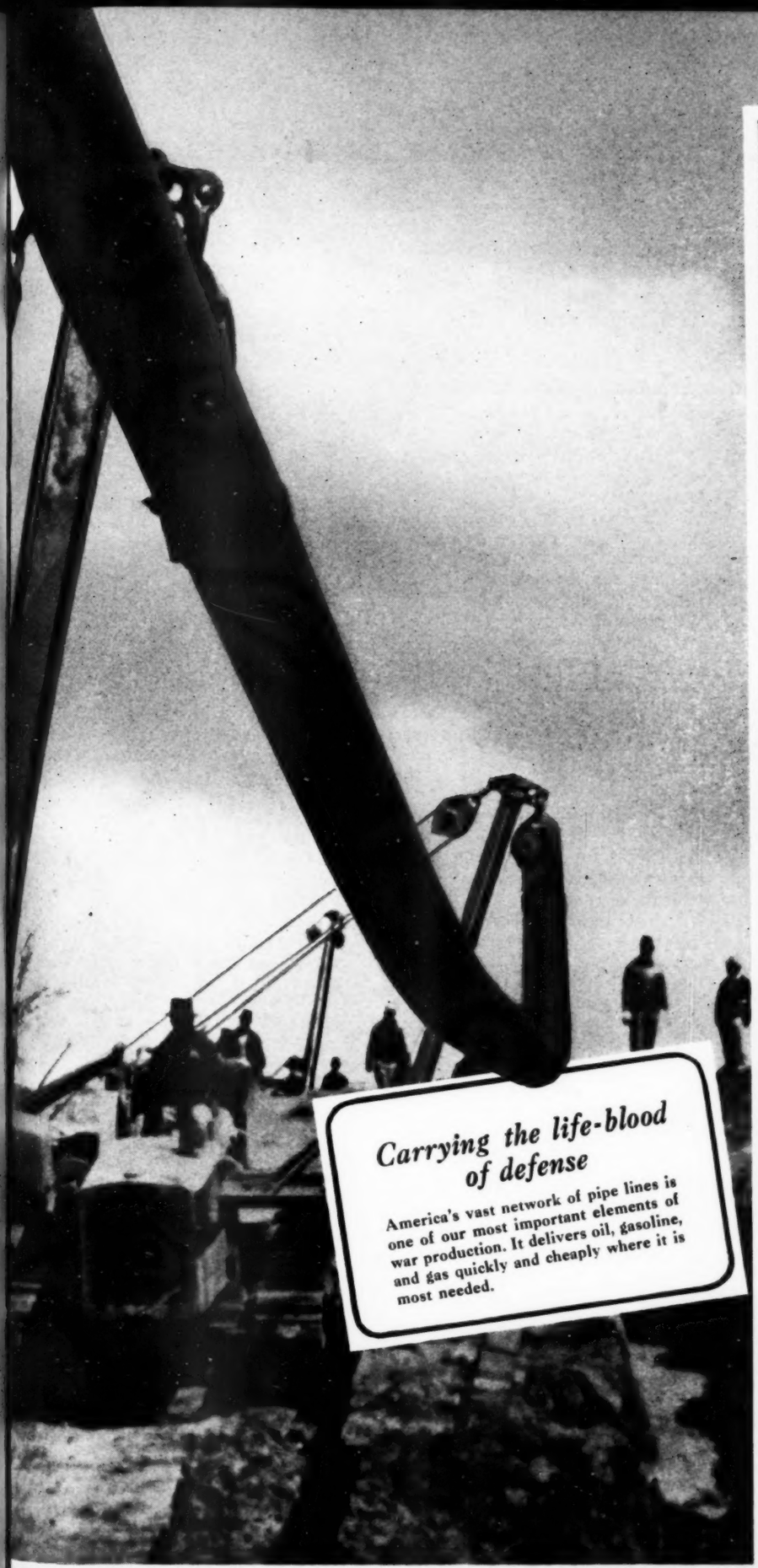
PRESERVATION of well-pumping equipment is now being given greater consideration than at any period in the history of the petroleum industry. This care is being exercised because of the necessity to prolong the life of vital equipment imposed on operators by priorities and the growing scarcity of vital materials. When wells are pumped without the assistance of a permanent derrick, the procedure followed in the not so distant past was to "tail" the stand of sucker rods out from the floor and drop the box end on the ground. This practice resulted in damage to threads and shoulders by the accumulation of dirt and abrasive sand. Later the practice of building long wooden troughs alongside the well was adopted, one for each location, which prevented much of the previous damage to sucker rods, but in themselves presented a fire hazard after a few pulling jobs because the timbers became oil soaked.

In recent months, many operators have abandoned the use of wooden rod troughs, and have devised metal stands upon which the rods are laid. These stands are generally made of material that permits quick and ready movement from the ground to the pulling machine, or truck, and likewise can be strung out at the well with little delay. One set usually suffices for as many wells as one pulling machine can service. These metal stands are portable, are easy to wipe clean when oil drips from the rods, and provide no fire hazard. The older wooden troughs represented a considerable investment, and the material from which they were constructed could not be utilized for another purpose once they were built and had become soaked with oil and crusted with drifting sand and dust.

Any welder can lay out the plan and easily construct a set of metallic rod racks, and the cost of material is a nominal one. The weight and size of the material from which a set of racks is to be made are governed somewhat by the depth of the wells and the size of the rods used for pumping. Under ordinary conditions 2-in. pipe suffices for the bearing member, which rests on the ground, and 1½-in. pipe for the risers. The cross member connecting the two risers can be made of any weight pipe that has sufficient inherent strength to support the weight of the rods without sagging or showing indications of bending. A part of the weight, however, is borne by diagonal braces welded to the foot of each vertical riser and to a point near the center of the cross member. The rack is additionally stiffened by welding diagonal braces from the outer end of the ground bearing member to the point where the cross member is attached. The length of the cross member should be governed by the number of rods to be laid on the rack. The upper end of each vertical riser should extend above the cross member sufficiently to prevent rods from rolling from the rack when the stack becomes high.

As many stands can be used in a set as are deemed essential, but in most cases when this type of support is used only three are thought to be necessary. The set is generally evenly spaced so that the rods are supported at three points to prevent any tendency to bend. On most pulling machines there is ample room to hang the racks when moving from one well to another, and when the racks are constructed with the factors of strength and light weight both in mind, one man can easily place them in position while the rest of the crew is rigging-up and getting ready to pull the rods.

——☆☆☆——



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So, You Want to be a Petroleum Engineer?

PART 4—*Selecting Your Alma Mater*

by Lester C. Uren

Professor of Petroleum Engineering, University of California

Continuing his series of articles under the general title, "So, You Want to Be a Petroleum Engineer?", in the present installment, Professor Uren discusses the factors that should be given consideration in selecting an educational institution in which to receive academic preparation in the field of petroleum engineering. The next installment, which will appear in the May issue, will offer a brief appraisal of the educational resources of the different institutions in the United States where petroleum engineering is taught. The sixth and concluding installment of this series, entitled "Bridging the Gap Between College and Industry," is reserved for the June issue. Earlier articles of this series appeared in the January, February, and March issues of *The Petroleum Engineer*.

A photograph and biographical sketch of the writer can be found on Page 27 of the January issue of *The Petroleum Engineer*, in connection with Part 1 of this series.

"GOD chooses most of our relatives, but you may choose your own Alma Mater! And a great deal depends upon making an intelligent choice. Too often a selection of a particular institution is made 'because Dad went there,' or 'because they turn out winning football teams,' or because their graduates seem to have good 'social standing.' Too frequently students go to the neighborhood college because 'one can get home over week ends' and parents don't like to send their children too far away. Often, too, economic considerations demand that the student select the least expensive college. An intelligent choice of an institution in which to receive a petroleum engineering education should, of course, be based upon a consideration of the character of the teaching personnel, the physical facilities available for instruction in this and related fields, and the general reputation and prestige of the institution among those who employ its graduates. The most distant school, the most expensive, even one that never won a football championship, may be the one that can best equip you for your career as a petroleum engineer.

Character of Teaching Personnel

"The old adage that a college may be simply a log with a qualified student eager to learn on one end and a good teacher competent in his field on the other, is still not a bad guide in making a choice. Massive granite buildings with marble stairways and bronze doors, surrounded by landscaped grounds, do not necessarily make a great university. Such a setting may also house a mausoleum. Even if such buildings were filled with all the necessary scientific instruments, chromium-plated, with shining glassware and fine oak furniture, the principal thing necessary to the making of a great university would still be lacking. The one essential thing is competent teachers: men capable of giving inspiration to the youthful mind; teachers experienced in the field in which they teach; conscientious, forward-looking men, sincerely believing that no work can be more worthwhile in the doing than helping to prepare the youth of the land for their future careers. A great university is a living thing: not a thing of stone and wood and metal.

"Most institutions of higher learning take great care in choosing among candidates for faculty appointments. They are, as a rule, men with a background of academic training and practical experience in the field to which their teaching relates: men who have attained some degree of recognition in their specialized professional fields or spheres of activity. Usually they have had advanced academic training and have been the recipients of higher degrees; often they have engaged in scientific research leading to professional publications. They should, above all else, be men who have the ability to transmit what they know to others in orderly, intelligible form: men whose personal qualities will contribute inspirational values to their teaching.

"Few men come fully prepared into a teaching position; their development is often gradual and perhaps extends over a period of many years concurrently with their teaching. The progressive teacher is not content with student relationships exclusively. He plans and conducts research projects; he seeks contacts with industry; he is active in professional societies; he engages in technical writing. His teaching is thereby enriched and in most of the better educational institutions the teaching load of members of the faculty is adjusted to permit of participation in such activities.

"When you choose your Alma Mater, appraise the quality of the teachers with whom you will be associated. Are they active in their profession? Are they well regarded professionally? Are they contributing to the advancement of knowledge in their respective fields? Are they respected among the graduates of the institution?

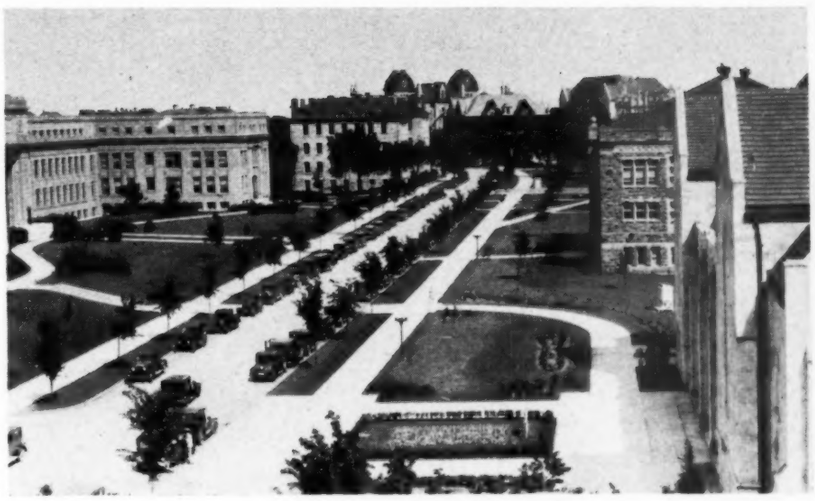
Character of Instructional Facilities

"Although quality of the teaching personnel should be the first consideration in selecting an engineering school, adequate instructional facilities are also an important essential. Suitably equipped laboratories for instruction in mechanics, heat, electricity and magnetism, optics and light, qualitative and quantitative analysis, organic chemistry, physical chemistry, determinative mineralogy, petrology, engineering materials testing, hydraulics, steam, electric, and internal-combustion engine-power development and transmission, are among the facilities that should be available for instruction in the fields of general science and engineering. Well-equipped drafting rooms for instruction in engineering drawing and mapping, and instruments for field instruction in surveying are essential. More specialized equipment desirable for laboratory instruction in different phases of petroleum engineering will be of particular interest. A complete development of petroleum engineering facilities might include separate laboratories devoted to oil testing and gauging, gas testing and metering, oil and gas reservoir drainage, core inspection and analysis, drilling fluid preparation and testing, cement testing, water analysis and emulsion inspection, well surveying and logging, oil production, oil storage, oil transportation, gas transmission, etc.

"In addition to laboratories, the modern university or college must have

a complete reference library, and museums in the several fields of knowledge will be helpful. Stereopticon slides and motion picture films and projectors, charts, maps and models, and other illustrative facilities are important elements of the educational plant. All physical facilities must be suitably housed; lecture rooms and offices must be equipped; buildings and grounds must be maintained; water, light, heat, communication, and other services provided.

"The physical plant and instructional facilities of a university or college properly equipped to teach petroleum engineering effectively, cost many thousands of dollars and require years of effort by the instructional staff in their development. Because of the great cost, comparatively few of the institutions now offering instruction in this field are adequately equipped. All could make effective use of additional funds if they could be made available.



View of a portion of the campus of the University of Kansas. The geology, mining, and petroleum engineering departments occupy the second building on the right

Large University vs. Small College

"The question is often raised concerning the relative merits of large and small educational institutions., Which is likely to offer the greatest advantages for the petroleum engineering student? There is something to be said for and against each, but perhaps a choice between them will depend upon the personal characteristics of the student more than anything else. Many are frankly critical of the very large institutions with their thousands of students and 'mass production' methods of education. Individual classes in some cases number many hundreds of students. In such cases, there is little opportunity for close personal relationships between teacher and students. Advisory work and recitation and "quiz" sessions must be entrusted largely to teaching assistants who may be youthful, comparatively inexperienced, advanced part-time students. Faculty and administrative relationships with students tend to assume an impersonal character. Students accustomed to close supervision in secondary schools find themselves placed largely on their own responsibility in a machine-like system of schedules, sections, rules and regulations, and formal examinations, the requirements of which they understand but vaguely.

"Some students do not respond well to such a system. They sometimes need continued supervision and pressure from some one whom they respect, to maintain adequate effort and discipline in meeting scholarship standards. It is thought that a large percentage of the many students disqualified during their first year in college, fail because of their inability to assume individual responsibility in meeting scholarship obligations. The small institution, with comparatively few students and opportunity for closer relationships between teachers and students, can provide closer supervision and to some extent, offset the tendency of immature students to evade individual responsibilities. On the other hand, in favor of the large institutions, many educators urge that it is a mistake to maintain the paternal atmosphere of the secondary school in college; that it is a part of the student's training for later life to develop in him a feeling of responsibility for his own shortcomings: to encourage him to meet his obligations of his own accord.

"The disadvantages of the large institution can largely be offset by proper organization. The large institution has many students but it also has many instructors and by a properly planned advisory system, each instructor need have no more students assigned to him for guidance than he can properly supervise. The large institution is generally able to attract superior instructors and to provide better instructional facilities than the small institution. There may be many hundreds of students in the better patronized courses, but the men who preside over them may be men of world-wide reputation in their respective fields: exceptionally able lecturers or men of great inspirational appeal. The small institution may be able to afford few such men; in the large institution, every subject may be taught by an outstanding authority. And for 'quiz' sessions and other phases of the work where individual contact with students is necessary, the large groups may be subdivided into many small sections, each in charge of a competent teaching assistant.

"The per capita cost of adequate laboratory and other instructional facilities may be prohibitive when assessed against a small number of students, yet not excessive when shared by many. The large institution, spending the same proportion of its income for laboratory facilities as the small institution, has a much larger amount available for this purpose. Accordingly, we should expect to find the larger institutions better equipped. The large institution has the very great advantage of wide diversification of offerings. It is possible for the student to combine with work in his major field, courses in almost any other field of knowledge in which he may be interested. Then, too, the large institution, as a rule, is better known and its graduates share its prestige.

The Junior College Question

"In some parts of the country, so-called 'junior colleges' have been established in great numbers. In some states, every city of consequence has its junior college and its establishment has in many cases been an expression of civic pride rather than necessity. Such colleges often develop as an adjunct of the high school, and progress of the student from high school to junior college may be accomplished with but little change in environment and outlook. The teaching methods are often those of the high school rather than those of the university. Offering two- or three-year programs, such colleges usually profess to train high school graduates for vocational occupations and to offer the equivalent of the first two years of a university engineering course.

"Should the prospective petroleum

The Engineering Building shown here houses the mining and petroleum engineering activities at Ohio State University

engineer spend the first year or two of his college course in a junior college with the expectation of transferring later to a university, college, or engineering school of senior rank? The student just out of high school, living in or near a city supporting a junior college, is often tempted or finds it necessary to do this. He can continue to live at home, perhaps at much less expense than would be necessary for his support at a distant university. The courses of the first two years are more or less standardized and may be as competently taught in a well conducted junior college as in a university. If competent teachers are employed and they are not required to teach too many different subjects; if the teaching facilities are adequate, if high scholarship standards are maintained, and the courses are conducted strictly on the college level, there can be no valid objection to the student spending the first two years of his college course in such an institution. Unfortunately, most junior colleges do not meet these requirements and the prospective student will do well to make careful comparison with a first class college or university before risking the possibility of inadequate preparation during these vital first two years of his college work. During this period, the foundations for the later professional courses are laid and much depends upon the quality of this foundation.

"The student transferring to a degree-granting institution after one or two years in a junior college, must contend with several disadvantages. Even though the quality of the junior college training has been adequate, he must become accustomed at a critical time in his academic career to strange surroundings and a new group of teachers. There may be differences in scope and content of courses previously completed. The instruction may be organized along different departmental lines. The junior college "transfer" is for a time, a stranger among his fellow students, unfamiliar with class customs and college traditions. He must develop an entirely new group of social contacts. It is not easy for him during his brief period of association before graduation to become sufficiently well known to achieve a position of leadership in student activities or to participate in organized sports. He is likely to be something of a 'misfit' among his fellows. Unless there are compelling reasons for attending a junior college, it is probably preferable that the student go directly from high school into the institution in which he hopes to receive his bachelor's degree.

Student Life

"The large institution is often situated in an urban center where, perhaps, it represents but a small segment of the community. Is life in this kind of an environment conducive to studious habits, or would the student find a more congenial atmosphere in a small town where the college community represents a large part of the population? Again, there is something to be said on each side of this question and the conclusion might finally be resolved into one of personal preference.

"For those who seek the simple qualities of college life, undiluted by foreign influences, the small town environment is probably best. Here the student meets and associates only with others of his kind; his entire time can be spent in the studious atmosphere of the college, devoted exclusively to academic pursuits, campus functions, and extra-curricular activities. The outside world with its distractions may come to seem very remote. The college becomes a place where 'ivory tower' dwellers may dissect and analyze to their hearts' content, unhampered by work-a-day problems.

"On the other hand, there are those who believe that if a college education is to be really successful in equipping young men to play their parts in the world of affairs, this detachment is destructive of the very qualities that education is designed to cultivate. This view seemingly would require the student to seek knowledge of the world and its people by close association with them: by placing the college in a large metropolitan center where it is surrounded by and made an integral part of the world it is designed to serve. In a large city are many industries, all kinds of people, a wider diversification of social and recreational advantages that smaller communities do not enjoy, and educational facilities of a kind that no college or university can offer. For the student who must seek part-time employment to 'pay his way,' there are better opportunities in the larger community.

"Some students are best sheltered from the world and its affairs until they are more mature and better able to assume an active role in it. Others profit by the opportunity for direct observation of man and his ways in the world laboratory.

Regional Influences

"As might be expected, most of the colleges and universities offering petroleum engineering curricula are situated in the more important oil-producing states; yet, this is not an essential condition. Proximity to the field is convenient, but not so important as other conditions, such as having a well-developed engineering school to serve as a background upon which to superimpose the petroleum engineering curriculum, and the provisions of competent teaching personnel and adequate instructional facilities. When these advantages can be concentrated in one institution, and in a community conveniently situated with respect to oil industry operations, the ulitmate is attained.

"Students naturally gravitate toward the better-known institutions in the regions in which they live. Eastern, Middlewestern, Gulf Coast, Rocky Mountain, and Pacific Coast regions are not only petroliferous provinces, but also educational provinces. Each has its own group of educational institutions in which will be found one or more prominent in the field of petroleum engineering education.

"After making his selection of an institution in which to do his undergraduate work, the student should normally remain there until he receives his bachelor's degree. If he then decides to undertake a year or two of graduate work, he might well consider doing

Mineral Industries Building, Pennsylvania State College, houses all activities relating to petroleum engineering instruction and research

this in some other institution, preferably in some other region. Each institution, each group of instructors has a certain contribution to make. Four undergraduate years is probably enough time for this. Additional time can be more profitably spent among another group of teachers in a different environment. A graduate of an eastern institution may thus spend a year or two in graduate work in a western, Mid-Continent or Gulf Coast school, or vice versa, and thus enjoy not only the advantages that result from a complete change in teaching personnel and educational environment, but also the experience of living for a time among a people of different regional outlook. Not only people, but educational institutions tend to become provincial, and the student who grows up and receives all his education in one region is apt to be provincial too. Each region, each people have something worthwhile to contribute to the education of the petroleum engineering student.

"The graduate years may be devoted largely to research and institutions affording special facilities for work of this character should receive favorable consideration. For some fields of graduate study, the institution selected need not necessarily be one specializing in the field of petroleum engineering.

Accrediting Colleges by E.C.P.D.

"The Engineers' Council for Professional Development, an organization sponsored by the several engineering societies and the National Council of State Boards of Engineering Examiners, has as its objective the enhancement of the status of the engineering profession. One of its useful functions is that of investigating the educational resources available in different institutions and accrediting their engineering curricula. Accrediting of a particular curriculum in an institution is certification in the name of the E.C.P.D. that its teaching personnel and facilities for training in the particular field of engineering represented by the curriculum, have been investigated by a committee of educators competent to judge, and have been found adequate. Graduates of approved institutions are supposed to have a preferred professional standing, especially in their relationship with state licensing boards.

"Each year the E.C.P.D. publishes a list of accredited institutions in each field of engineering. In a bulletin issued in October, 1941, the Council lists the following 13 engineering schools, colleges, and universities in the United States that offer approved petroleum engineering curricula:

University of California
Colorado School of Mines
Louisiana State University
University of Minnesota
New Mexico School of Mines
University of Oklahoma
Pennsylvania State College
University of Pittsburgh
University of Southern California
Stanford University
Texas A. & M. College
University of Texas
University of Tulsa

"In addition to these, there are listed six other institutions offering approved curricula, primarily in other related engineering fields, but providing 'options' within these fields substantially equivalent in scope to complete petroleum engineering curricula. These institutions and the related engineering curriculum of which the petroleum engineering option is a part, are:

University of Illinois
(Mechanical Engineering)
University of Kentucky
(Mining Engineering)
Missouri School of Mines
(Mining Engineering)
Ohio State University
(Mining Engineering)
Oklahoma A. & M. College
(Mechanical Engineering)
West Virginia University
(Mining Engineering)

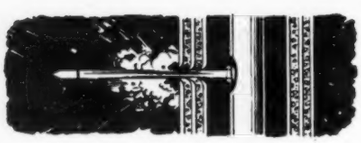
"The absence from these lists of several institutions that offer instruction in the field of petroleum engineering, is not necessarily to be taken as an indication that their curricula have been disapproved by the E.C.P.D. In some instances, their facilities have not yet been appraised and additional institutions are being added to the approved list from year to year, as they are found qualified to meet the E.C.P.D. standards.

"How are we going to make a selection of one among so many accredited institutions? Well, that's something every one must decide for himself. But look for me again next month about this same time and we'll discuss the educational advantages of the different institutions, with particular reference to the needs of the petroleum engineering student."

——☆☆☆——

Petroleum engineering activities at the University of Pittsburgh are centered in the building here shown

Lane-Wells INVITES the TOUGH Gun Perforating Jobs



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Economics of Gravel-Packing in Semi-Depleted Loma Novia Field*

☆ Records of approximately 100 gravel-packed wells show an increase in immediate production of 143 percent and a settled increase of 93 percent

by Don L. Harlan
Petroleum Engineer, The Texas Company

MORE than 200 wells in the semi-depleted Loma Novia field, Duval County, Texas, have been gravel-packed during the last year. The relatively inexpensive, simple method and highly satisfactory results have made the practice well-known to almost every operator in the field. Results have been particularly good in areas in which repressuring or gas drive has been applied. The two methods seem to have worked "hand in glove" to rejuvenate the formerly rapidly declining Loma Novia field.

Location and Early History

The Loma Nova field embraces an elliptical area about 8 miles long and 2½ miles in width at its widest point, and includes approximately 6700 acres. Its long axis runs southwest-northeast about 2 miles east of the town of Freer (see Fig. 1). The discovery well was completed December 27, 1934. In a little more than two years the field was drilled-up, a total of more than 700 wells on 10-acre spacing having been drilled. Wells are 2550 to 2850 ft. deep and produce oil of 25-deg. and 27-deg. gravity A.P.I.

Reservoir Conditions

The reservoir is formed by the monoclinal Loma Novia sand lens, or lenses, pinching out to the northwest against an old shore line. A fault, down-throw on the southeast, bounds the field to the south and southeast. The producing horizon is 5 to 25 ft. thick and dips about 270 ft. from west to east. Sand porosity varies from 20 to 30 percent and permeability from 7 to 5000 millidarcys. These wide variations are due more or less to discontinuous interbedded shales and to the presence in the sand of fine "bentonitic" material in varying quantities.

Apparently there are several members in the Loma Novia series and a few major lenses may be identified and their strand lines traced within the limits of the field (see Fig. 2). The overlapping of these separate members forms areas of high productivity, locally known as "good sand areas," and the lack of such overlap, together with relatively lower porosity, permeability, and saturation, forms "tight streaks" that consist chiefly of sandy shale and shells, and poorly-sorted shaley sands. There is a definite continuity in the Loma Novia Series, however, as proved by the highly successful use of gas drive.

DON L. HARLAN

graduated from Texas University in 1933 with a bachelor of science degree in petroleum engineering—Employed by The Texas Company August 23, 1933, as an apprentice roughneck in the Port Neches field, Texas—Became evaluation engineer in the company's Houston office in 1934—Was made district engineer in 1935 for the eastern Gulf Coast area—In 1937 he was sent to Trinidad, British West Indies, as field superintendent of the Antilles Petroleum Corporation, Ltd., a subsidiary of The Texas Company—Returned to United States early in 1940 when the war curtailed operations in Trinidad—Is now district engineer for The Texas Company in the Freer-Laredo district, making his headquarters at Freer, Texas.

Reservoir Content

Few saturation determinations have been made but the oil content of the reservoir is believed to have been lower than average. Original bottom-hole pressure was 1050 lb. Gas-oil ratios have been low throughout the life of the field, averaging 350 cu. ft. per bbl. Originally there were a few small dry gas areas along the western and northern edges of the field and along the strand lines of at least one of the lenses that pinch out within the field (see Fig. 1). This gas was dissipated early in the life of the field. There is no true water drive. Only a few wells along the extreme southeast margin of the field produce salt water despite the fact that reservoir pressure is now practically exhausted. As is true in most Southwest Texas fields of this type, however, fresh water, probably connate, is present in relatively small amount and was unnoticed in the early life of the field but appeared as reservoir energy was dissipated. It has left its mark in every operator's production record by hydrating the bentonitic material, causing it to swell and form a gummy mud that in many cases has effectively sealed the formation around the wells, filled annular spaces between the face of formation and the liners, and clogged the liners themselves so that the remaining reservoir pressure is insufficient to move any oil into the wells. Enough fine sand and silt find their way into the well to clog valves and score the pumps, thus necessitating frequent and expensive pulling jobs.

In all probability most of this water was originally contained in the less permeable lenses of the sand, probably chiefly in the upper portion, which was described as "shaley sand and shells." Also, it is possible that as the pressure in the more permeable portions of the sand was depleted, this water moved out of the tighter lenses into the wells, thus causing numerous difficulties. Many liners were pulled, open holes

*This paper was presented at a recent meeting of the Petroleum Industries Association, a group of company engineers and others in the general vicinity of Corpus Christi, Texas, who are interested in studying some of the many drilling and production problems encountered in this strategic area.

bailed and underreamed, and liners reset to remove the resulting mud from the wells, but results were unsatisfactory and production increases short-lived because more mud accumulated in a short time. It is believed that the early application of repressuring, or gas drive, has in many cases prevented and retarded this movement by preventing the complete dissipation of reservoir pressure.

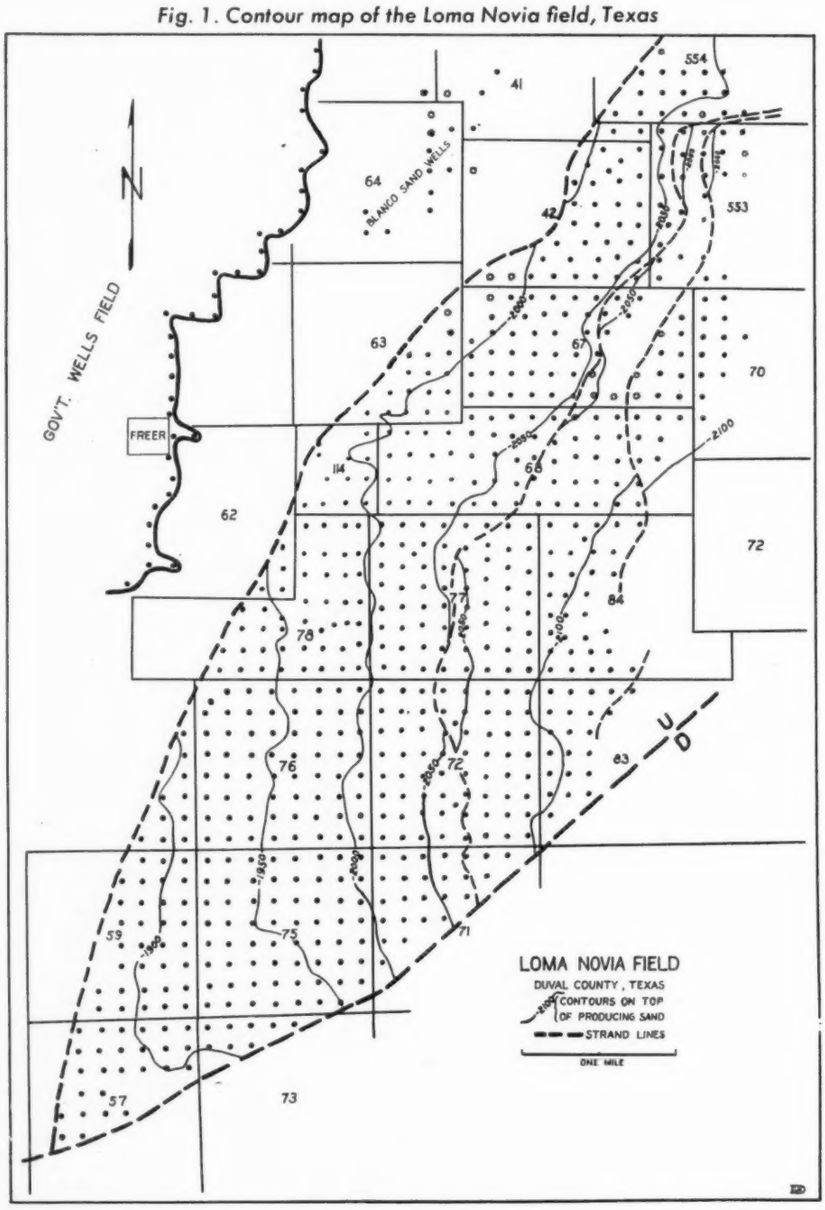
Production History

Initial potentials of wells were as high as 50 bbl. per hour, but because of the low gas content of the reservoir and the lack of effective water drive, there was a very rapid decline in potential that, as is usual in prorated fields, went unnoticed until the wells went on the pump after an average flowing life of 18 months. Later, as the pumping wells ceased to make their allowable, copper tubing "equalizers" were installed on many wells to bleed-off casing pressures into the flow line and, still later, many wellheads were opened to atmosphere. Thus was the reservoir energy rapidly depleted in an attempt to maintain allowables.

Early Remedial Attempts

In 1939, when the field had produced about 19,000,000 bbl., or about 11 percent, of the estimated original oil in place and perhaps about 40 percent of the normally expected ultimate from a field of this type, so many leases had ceased to produce their allowables that the operators concluded that the field was declining far more rapidly than normal and that some method must be found to increase recovery. Various types of work-over jobs were tried including cleaning-out open hole and resetting liners, shutting off muddier portions of sand with open-hole packers, acidizing, shooting with nitroglycerin, gun-perforating, gravel-packing inside of liners, and cementing stub liners. Some relief was obtained, but in general results were poor and uneconomical.

Fig. 1. Contour map of the Loma Novia field, Texas



Repressuring, or Gas Drive

About this time several operators began to experiment with gas injection and results were so promising that a concerted effort was made to unitize the field under one coördinating committee to apply gas drive, or repressuring, throughout the field. This attempt failed but a group of independent operators controlling the southwestern one-third of the field did organize and place their leases under the direction of a consulting engineer experienced in gas-drive operations. Two major companies also extended their experimental operations so that at present more than two-thirds of the field is under the influence of a relatively coöperative repressuring program. Two other major companies with extensive holdings will probably begin gas injection on a large scale in the near future. This effort has been rewarded by a marked flattening in the production decline curve of the field and some leases have enjoyed substantial increases in oil production before the application of gravel-packing operations.

Need for Gravel-Packing

Studies of the results of the repressuring operations showed that some wells were not receiving the benefit of the gas drive and in some areas the increased flow of fluid into wells brought larger quantities of mud and floating sand, which caused excessive pump wear. It was then decided that the accumulated mud must be removed from the producing wells and its re-accumulation prevented.

Gravel-Packing Instituted

As some success had been obtained in eliminating excessive pump wear by filling the inside of liners with pea gravel, it was believed that, if the annulus between the walls of the hole and liner were cleaned out and filled with gravel, the muddy portions of the horizon would seal themselves by depositing sticky mud in the gravel and that the better sand lenses would be

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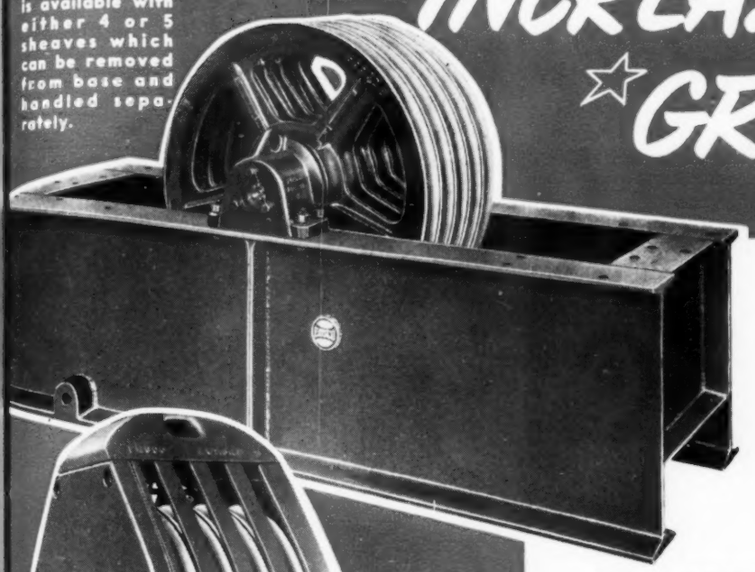

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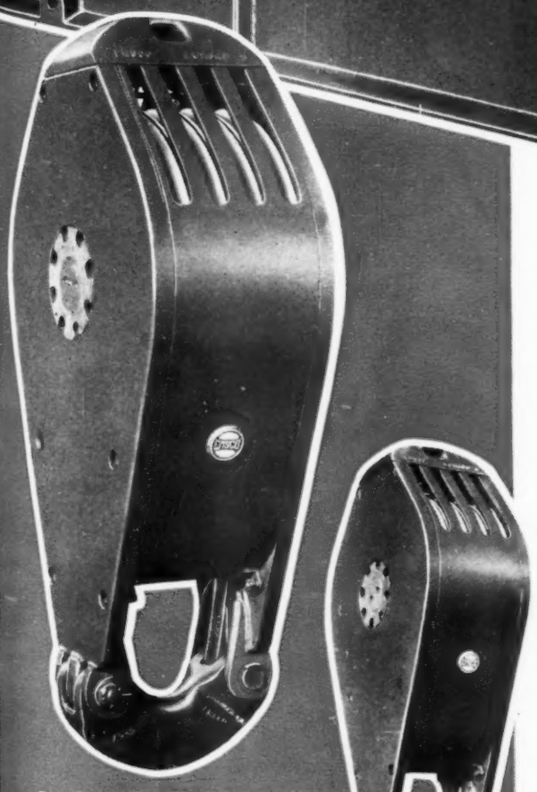

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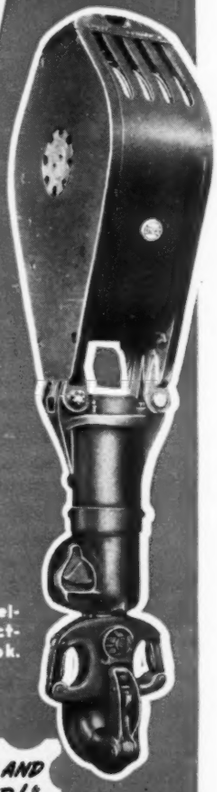

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left open to deliver the relatively cleaner fluid into the well through the gravel; also, that if a large cavity could be formed and maintained with gravel, the increased drainage area would result in higher potentials.

Accordingly, liners were pulled, open holes bailed clean, and various methods of underreaming and breaking down formation were employed including shooting with nitroglycerine, acidizing, underreaming with offset cable-tool bits and with wire-line "mare's tail" underreamers through cable-tool bits, etc. The cavities thus formed were then filled with washed and screened pebble, pea gravel, varying in size from ¼ in. by ½ in. to ⅝ in. by ¾ in. and perforated or slotted liners driven through the gravel to total depth of hole. Liners were then bailed clean, tubing and rods replaced, and the wells put back on the pump.

Present Method

The most popular current gravel-packing method is as follows:

(1) A cable-tool spudder is moved on location and rods and tubing pulled.

(2) The inside of the liner is bailed clean of mud and sand using a sand pump.

(3) The top and bottom of the liner are checked with a measuring line to assure correct measurements.

(4) The liner is then pulled using cable-tool stem, jars, and spear (little difficulty has been eperienced in pulling liners).

(5) The open hole is then bailed clean of sand and mud using dart bottom bailer and sand pump.

(6) A 1-ft. length of 1⅛-in. wire line is then threaded through and wedged in a horizontal hole drilled through a cable-tool bit. This device is locally known as a "mare's tail" or "tickler." The "tickler" is run to bottom on jars and stem and stroked up and down the entire open hole by rocking the beam and raising and lowering tools.

(7) When the open hole has become "logy" with caving, tools are removed and the hole cleaned out to bottom with a sand pump.

(8) A longer wire line is then wedged in the bit and the process repeated using successively longer "picklers" up to 4 ft. long until a satisfactory cavity is created. Water was placed in some early wells using dump bailer, but this practice has been eliminated because, even though greater cavities could be formed, more mud also accumulated and the purpose of the process was defeated. Any excess caving of shale from around the casing seat is usually halted by loading the well with 200 or 300 ft. of oil. This reverses the flow of fluid across the face of the sand and tends to control caving.

(9) When a sufficiently large cavity has been created and cleaned out, gravel is merely poured into the casing in batches of 5 to 10 cu. ft. Oil is sometimes allowed to flow into the casing in small quantities while gravel is being poured to prevent undue breakage of pebbles on casing joints. A measuring line or bailer is run after each batch of gravel to ascertain the rate of fill and the shape of the cavity. Use of a bailer for this purpose allows some tamping and leveling of gravel in the cavity. The amount of gravel placed varies from 1½ to 5 yards, the average being 3 yards.

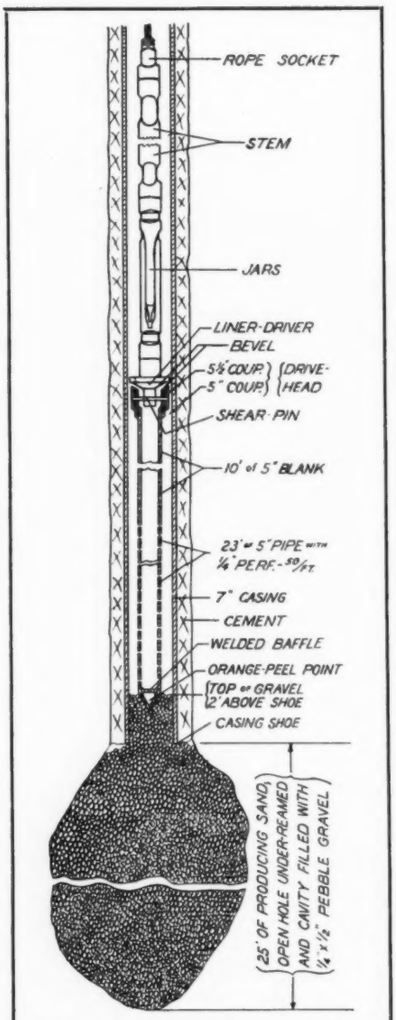


Fig. 3. Driving tools with liner in position to be driven through gravel

Fig. 2. Idealized dip cross-section of the Loma Novia, Government Wells, and Blanco sands

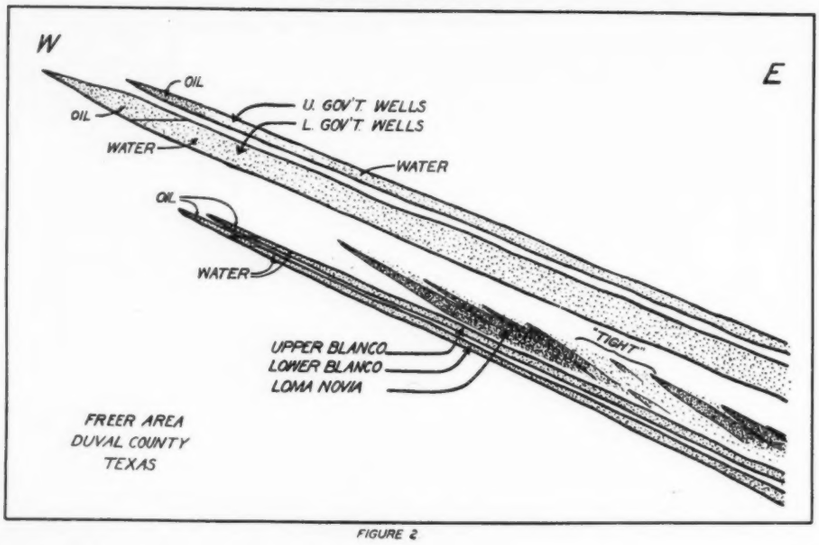
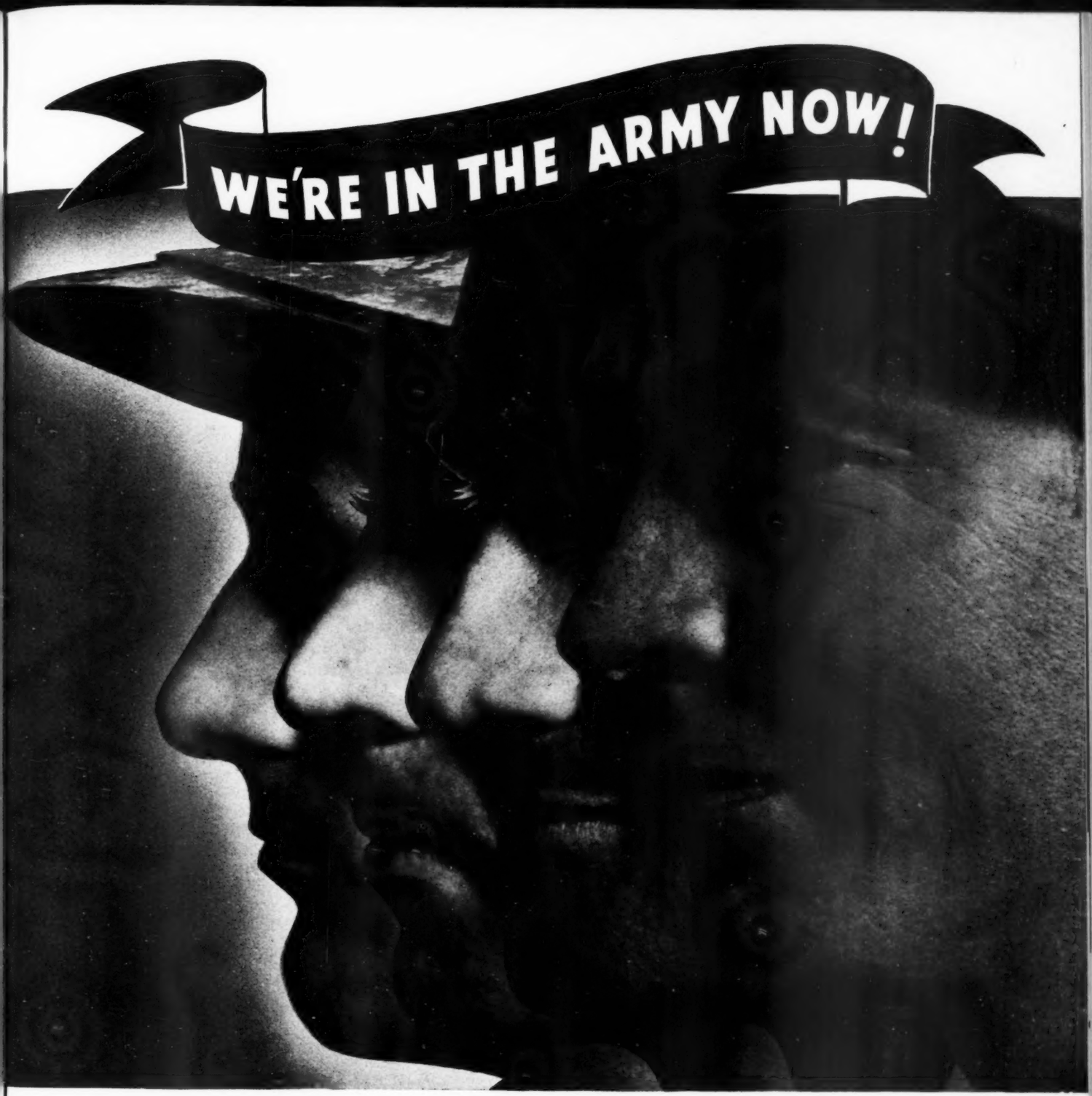


FIGURE 2

(10) When the open hole and 2 ft. of casing are filled with gravel, a liner with "orange peel" point and protecting baffle on bottom, perforated from bottom up high enough to reach within 2 ft. of the casing shoe and with drive-head or pin-coupling on top, is run-in on cable-tool pin that supports liner driver, jars, and stem (see Fig. 3).

(11) The liner is driven through the gravel to total depth, this operation usually requiring from ½ hour to 6 hours jarring, depending on the size of the cavity obtained. Perforations are ⅛-in., 3/16-in., or ¼-in. round holes, 50 to 75 per ft., or 0.014-in., 0.016-in., or 0.020-in. slotted pipe. Liners are 4 in. O.D. for 5½-in. O.D. casing and 5 in. or 5½ in. O.D. for 7-in. O.D. casing. Drive heads for 4-in. liners are made by threading the outside of the 4-in. top coupling and screwing over it a 4½-in. coupling. Those for 5-in. O.D. liner are made by placing a 5½-in. coupling over the top 5-in. coupling. The top of the



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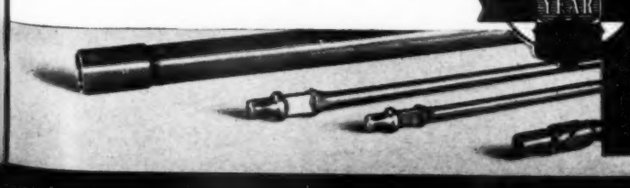


AXELSON SELLS AND *SERVICES* DEEP WELL PLUNGER PUMPS AND SUCKER RODS

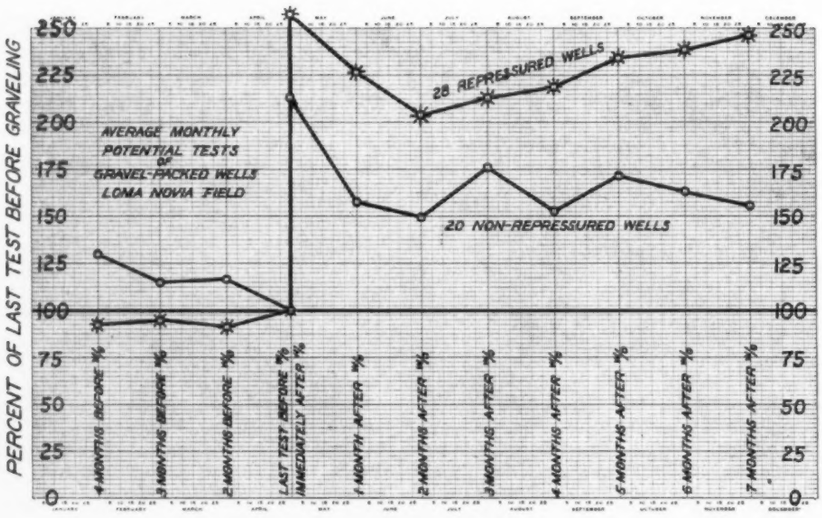


Fig. 4. Average monthly potential tests of gravel-packed wells in Loma Novia field

drive head is beveled inside to allow easy entrance of tubing or bailer and the driving surface of the liner driver is beveled to fit.

(12) When the liner is on bottom and checked with a measuring line, the inside of it is bailed clear of broken-up gravel and settled sand and the well put back on the pump in the usual manner.

Costs

Cost of gravel-packing wells in this manner varies widely because of a difference in arrangements with company and contract spudders, time allowed for each well, variations of method, and varying sand conditions. Downtime is from 4 to 10 days. Some operators prefer to hurry the job to save spudder expense, but this is almost invariably reflected in smaller yardage placed and in smaller and less prolonged increase in potentials. Cost of spudder time, gravel, labor, and material varies from $400 to $1200 per well, and an average of $600 per well for nearly 100 wells gravel-packed by several operators. This does not include supervision or other overhead.

Results

Of the 200-odd wells that have been gravel-packed in the Loma Novia field, approximately 100 have been back on production long enough to determine the increase in settled potentials. The total potential of these wells before and after gravel-packing is:

2 months before, bbl.	*Immediately before, bbl.*	*Immediately after, bbl.*	*2 months after, bbl.*
693	659	1594	1271

This represents an immediate increase of 143 percent and a settled increase of 93 percent over the total potential immediately before gravel-packing. Some operators with relatively large numbers of completed jobs show an immediate increase of as much as 230 percent and a settled increase of 203 percent over the potential immediately before the work-over.

Fig. 4 represents the average monthly potential tests of 28 wells in repressured areas and the average monthly potential tests of 20 wells in non-repressured areas expressed as percentages of the last potential tests of the same wells before they were gravel-packed. These wells were chosen because they are among the oldest gravel-pack jobs in the field and because their monthly potential tests were made available to the writer.

It is noteworthy that there was a slight upward trend in the average well in repressured areas before being gravel-packed, but a definite downward trend in the potentials of wells in non-repressured areas prior to gravel-packing. It is also notable that repressuring resulted in greater percentages of increase in potential immediately after the work-over and that, after an early drop in potential, the repressured wells recovered and continued to increase at an accelerated rate whereas the wells in non-repressured areas suffered a more pronounced early slump and have erratically trended downward after a recovery in the third month after gravel-packing.

The greatest benefits from gravel-packing, however, have not been in increased potentials but in elimination of down-time, costly repairs to pumping equipment, and expensive pulling jobs. Almost every operator reports a decided decrease in pulling jobs. Whereas previously time between jobs was counted in weeks, it is now counted in months. One operator has pulled only two wells of 44 gravel-packed during a 10-month period.

Practice Spreads

In this connection it should be pointed out that whereas this method of gravel-packing is peculiarly adapted to low-fluid-level, bentonitic sands of the Loma Novia and O'Hern fields, the practice has been carried out on a large scale in the higher-fluid-level nearby Government Wells, Seven Sisters, and other fields, not to increase potential, but to eliminate sand trouble and the resulting stripping jobs, some of which are as expensive as gravel-pack jobs. Also, it might be mentioned that, although this method is not feasible in high-pressure fields, the parent circulation method of gravel-packing has proved very effective in eliminating sand troubles in flowing fields from California to South America and merits consideration as one means of preventing currently developed fields from attaining the low-production stage reached by Loma Novia in 1939.

—— ☆☆☆ ——

Repairing Patented Parts of Petroleum Machinery Unlawful

ACCORDING to the law, you as an owner of petroleum equipment have no legal right to make repairs on patented parts of such machinery. Perhaps you *have* paid in full for the equipment. Perhaps it *is* legally yours. But that makes no difference in the eyes of the law when it comes to repairing or replacing the *patented* parts. You may break or completely destroy the patented parts if you feel like doing so. Ownership permits destruction but it does *not* permit *building up* of machine parts that are protected by patent.

Patents often apply only to few specific parts. You may do whatever you wish to the *unpatented* parts, of course, but the patented portions must not be repaired by you or by anybody else without the permission of the patentee. Anyone supplying parts for patented portions or repairing those parts who is not licensed by the patentee to do so is subject to damages for infringement.

"Welding saved me $1 on that tankful"

What's the idea of giving me the welding nod every time I buy gasoline?

ALTER EGO: Just because you're searching through today's welding achievements for help in developing a crash-proof business for the future. So, look into the modern oil refineries for a cue.

That's right, they're all-welded so that they can work at higher pressures and thus turn out more gasoline per gallon of crude.

ALTER EGO: To be more specific, they've *doubled* the yield from crude, which cuts costs at the pump 5 cents per gallon. That's how you just saved $1.

Then why couldn't we put that same basic idea to work to boost the quality and cut the cost of our *product.*

ALTER EGO: We *could* if we *would*. All it takes is the *will* and the *way*. I'll furnish the will. You can get the *way* from The Lincoln Electric Company, Cleveland, Ohio. Drop them a line, state your problem and ask for change-over guidance. There's nothing to lose—everything to gain.

ALTER EGO: Literally, "one's other self"—the still, small voice that questions, inspires and corrects our conscious action.

Overcoming Difficulty of Separating Water from "Slop Oil" in Refinery

☆ **Adaptation of equipment used to remove water from gasoline solves problem of waste water disposal**

by R. G. Lovell

Development Engineer, Hancock Oil Company of California

IN A PREVIOUS article the writer described a device that had been found to be very satisfactory for removing water from gasoline in the line from the straight-run condenser to run-down tank.

Alertness of an executive of a Mid-Continent producing and refining company enabled him to see a potential extension and adoption of the idea to include a new application. Both refineries of this Oklahoma company were confronted with the same waste water disposal problem as are many other plants. There were strict prohibitions against disposal into adjacent land of a waste water containing oil. To accomplish a complete separation entailed large, and consequently costly, concrete pits. To cover these pits to prevent loss of vapors is, obviously, impracticable. Therefore, the vapor loss has been accepted as a necessary evil. In many refineries this loss has been no inconsiderable amount.

A further difficulty was involved in combination skimming and cracking plants. To run slops from both plants into a common separator meant that the reclaimed oil was recoverable only in the form of cracking plant feed stock, as the lighter straight-run fractions would suffer loss of color and freedom from sulphur by contamination with cracked stocks.

Because the extension of the idea has proved to be of such distinct value, it is believed that the manner in which the original idea was worked out would be of interest together with a description of the methods used in conjunction with the new development. The previous article[1] is quoted from as follows:

From Condenser to Run-Down Tank

"There is now a mixture of liquid gasoline and water to be handled, which should be separated and the water discarded as quickly as is practicable. Three reasons are manifest for accomplishing this separation before reaching the run-down tank: first, water in the tank is not 'pay load'; second, more active corrosion on tank bottom occurs when water is present, and third, evaporation losses are greater from a gasoline-water mixture.

"Many devices have been developed to make this separation automatic but not all have proved successful. Included are those that depend upon a weighted float and compound leverage for operation. The operator will often elect to make periodic manual water withdrawals from the rundown tank because of the ever-existing possibility of gasoline running to sewer for a considerable time before discovery, through failure of the float mechanism to function.

"Another type that does not depend in any way upon floats or mechanical equipment, is shown in accompanying sketches, Figs. 1 and 2. The only objection that the writer has ever heard to the use of this type is that wide variation in the specific gravity of the gasoline would require a change in point of water drawoff. We shall see directly if this objection is justified.

"Fig. 1 shows how the desired end can be accomplished in the conventional way when the separator is not intended to function as a reflux accumulator.

"Fig. 2 is shown with a baffle, or separator, which provides a reservoir for reflux. Great care must be exercised in the manufacture of the type shown in Fig. 2, for the results of even a slight leak in the joint between the baffle and the body may be serious. In both instances provision must be made to transfer any vapor pressure from the body back to the vapor space of the rundown tank where the vapor can be taken care of by the regular tank vapor relief devices.

"The very simplicity of this type of separator has caused it to be subjected to close scrutiny and some amount of skepticism. It has been difficult for many to realize that the point of water drawoff can be above the water level in the body. Certainly the most satisfactory way of dispelling this skepticism is to reason out the matter by designing a unit to handle the duty for a typical case using the same values that have been set-up heretofore.

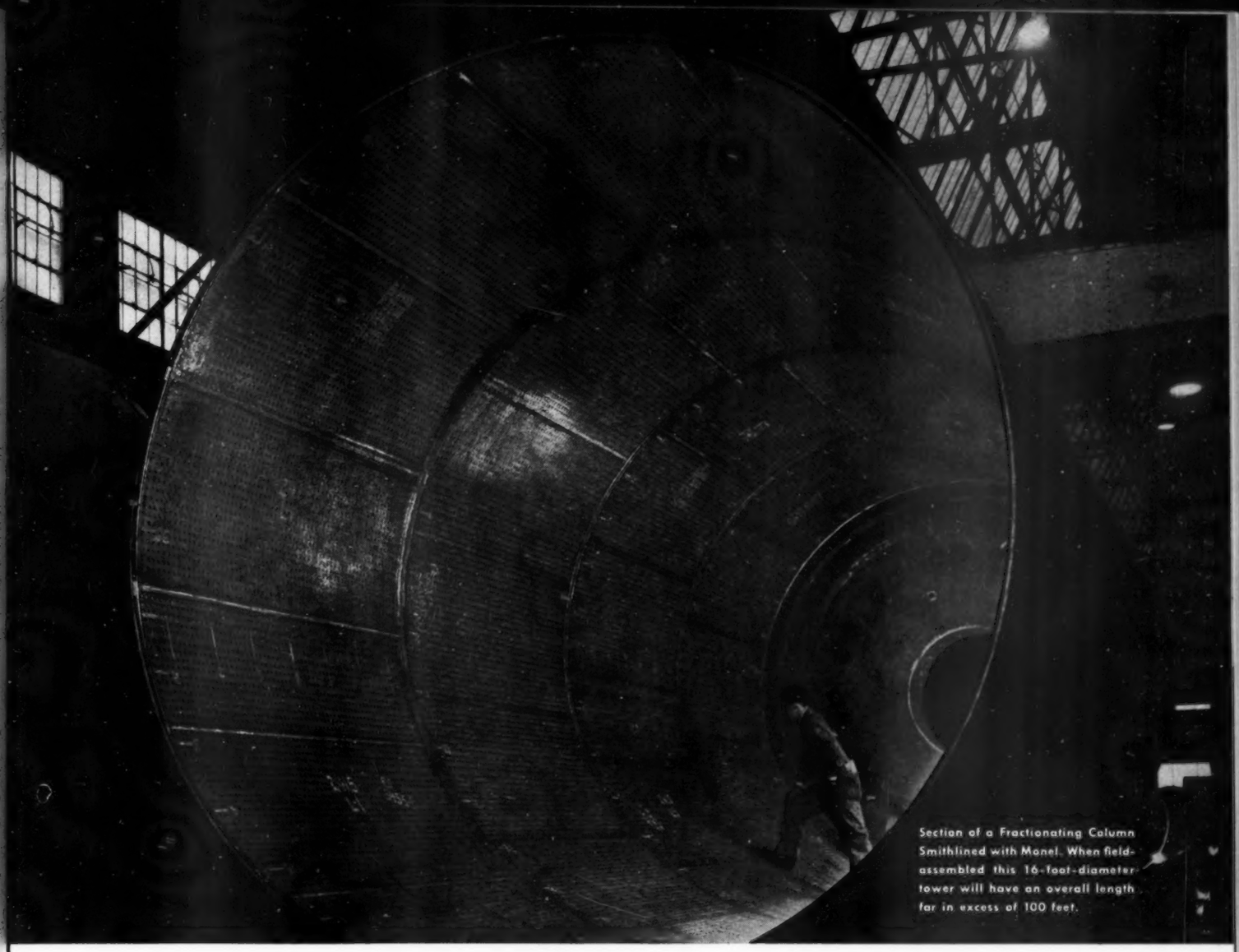
The Volume Duty

"The total amount of distillate, including steam and reflux, was developed in the last calculation as 3680 gal. per hr. of which 180 gal. is water. The job, then, is to select a vessel that will be ample in area to permit complete

R. G. LOVELL

received his academic training in New York and served several of the larger mining and milling companies of New Mexico, Arizona, and the Republic of Mexico as power engineer and master mechanic from 1908 to 1917, then saw military service in the engineering corps until 1919—Returning from the war he became affiliated with the oil refining industry, first with Standard Oil Company of California as refinery construction engineer and later with a foreign company—Later he was made assistant to the chief engineer of Pan American Petroleum and Transport Company for the construction of their California processing properties—He has been with The Hancock Oil Company of California since that time.

[1] "Refinery Piping — Design of Stock Lines From Tower," by R. G. Lovell, *The Petroleum Engineer*, Annual Number (July 1), 1941.



Section of a Fractionating Column Smithlined with Monel. When field-assembled this 16-foot-diameter tower will have an overall length far in excess of 100 feet.

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Building this or any other corrosion-resistant pressure vessel takes more than just adequate facilities. It takes engineering skill . . . specialized experience . . . knowledge gained through continuous production and research. In short, it takes real "know-how."

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separation of the water, and of such height that the gasoline can flow by gravity to the rundown tank, and the water be discharged to sewer by an open jet so that it can be checked readily. Observe in the accompanying sketches that the gasoline level is controlled entirely by the height of the weir, which must, of course, be above the highest point in the rundown line. This does not necessarily involve an unduly tall separator as there is usually plenty of vertical distance in which to work, and the condensers can be placed high enough to provide liberal clearance.

"Assume a diameter of 5 ft.10 in. and a distance of 4 ft. from point of entry of the gasoline-water mixture to the normal gasoline level. The contained separation area will be 600 gal. If the mixture to be separated is entering at a rate of 3680 gal. per hour, or 60 gal. per minute, any unit portion of the liquid will require 10 min. to reach the weir and pass out. This is ample time to insure that no water will remain entrained with the gasoline. If the vapor space of the separator is connected with the vapor space of the rundown tank, as has been recommended, no condition of vapor pressure can alter the time allowed for the separation to take place. And, no matter what method of removing the gasoline from the separator is used, the time element is not changed so long as there is a break between the weir and the outgoing stream.

"Having found that 4 ft. is ample travel time in which to remove completely the water from the gasoline, we next need to know how much travel time to allow for the water to rid itself of the gasoline before entering the water discharge line. The water is only 5 percent of the total volume but the penalty of carryover is loss of gasoline. Prudence, therefore, indicates still slower travel. Three ft. of water depth should be entirely satisfactory and safe. The total height, then, from the bottom of the body to the normal gasoline level will be 7 ft. A vapor space of 3 ft. should insure against any rapid rise in vapor pressure.

Locations of Water Drawoffs

"The height above the bottom of the body at which the water drawoffs are taken is not determined by the relative volumes of the two liquids. These points are established by the dimensions just used, taken together with the specific gravity of the gasoline. As a basis for the first calculation we will assume an A.P.I. gravity of 57° (0.75 actual specific gravity) for the gasoline. The pressure exerted by a 4-ft. column will be 4×0.434 (pressure of a column of water one ft. in height) $\times 0.75 = 1.3$ lb. per sq. in. Three ft. of water will exert an additional pressure of $3 \times 0.434 = 1.2$ lb. per sq. in. The total pressure inside the separator that forces the water up in the leg is 2.5 lb. per sq. in., which will support a column of water

$$\frac{25}{0.434}, \text{ or } 5.76 \text{ ft.},$$

which is 5 ft. 9 in. *If a water outlet is located at this distance above the lowest point in the separator and the gasoline is approximately 57° A.P.I., the unit will function without attention and no one need go near it.*

"Refinery operators know that the gravity of the gasoline stream can change suddenly for several reasons. Let's see how the proper functioning of the separator is going to be affected by such changes. Suppose, for instance, that the crude oil charge pump should speed-up without the heater fires being increased, or that the fires become diminished without change in the charging rate, or that the distillation steam supply is reduced. The effect would be the same in any case. The gasoline cut would be less deep, with a consequent increase in its A.P.I. gravity or lowered specific gravity. The water-gasoline ratio would also be affected by change either in fire or charging rate, but not to any considerable degree by a reduction in amount of steam. In the latter case, as the steam was reduced so would be the amount of vapor distilled; therefore, the ratio would not be materially changed.

"In the event of either of the first two contingencies, the total amount of liquid coming to the separator would be considerably reduced, but this would

Gasoline-Water Separator

Fig. 1

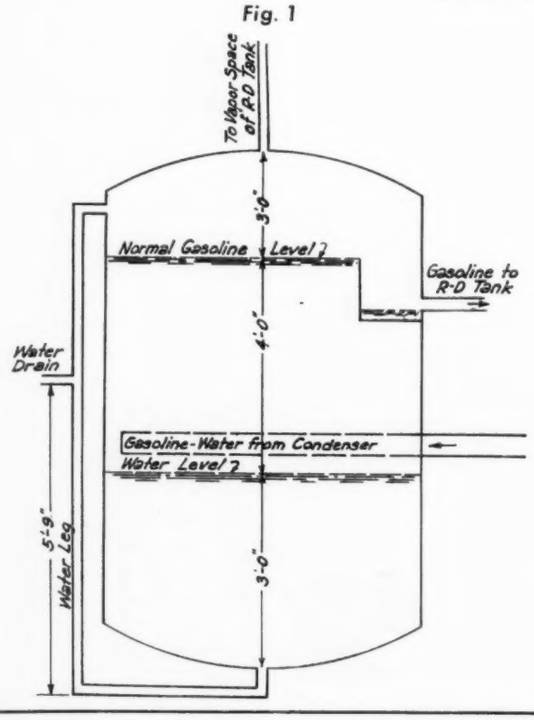
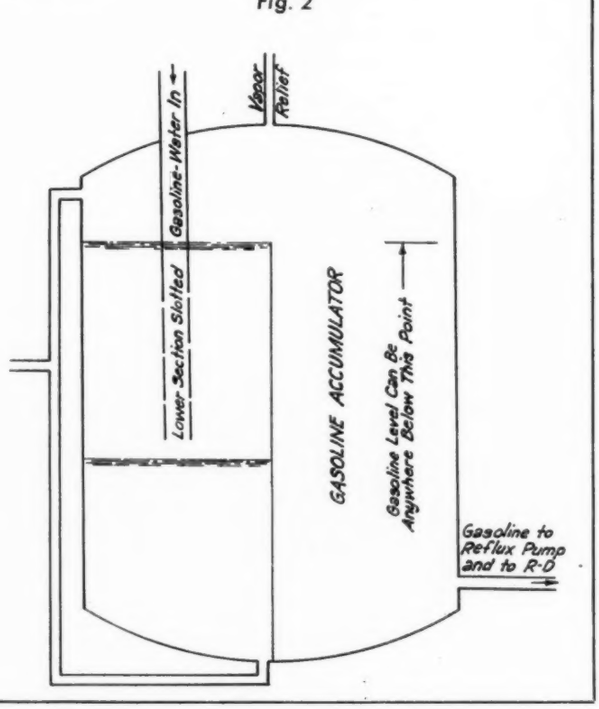


Fig. 2


Vapor Relief
Gasoline-Water In
Lower Section Slotted
GASOLINE ACCUMULATOR
Gasoline Level Can Be Anywhere Below This Point
Gasoline to Reflux Pump and to R-D

In WAR or PEACE its Vogt for better HEAT TRANSFER EQUIPMENT

1. Heat Exchangers in the foreground have monel metal shells, admiralty metal tubes and naval bronze tube sheets, floating head covers, and baffles. Vogt Ell Bolts are used on floating head covers.
2. Reactors for catalytic polymerization units being assembled and tested. Each is of welded construction and has bolted-on hinged covers.
3. Group of Diesel Oil Exchangers for a visbreaker. Used to exchange heat between diesel oil and corrosive crude containing salt and sulphur compounds.
4. 62"x30'-6" long Gas Cooler for a catalytic unit in a large refinery. Tube bundle at right is for a second unit.

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A TYPE AND SIZE FOR EVERY PURPOSE

have no effect upon the normal gasoline level. The gasoline would simply pass over the weir at the same reduced rate and, as the rate of water remains the same, the volume of water would tend to increase. Recollect, then, that the height of water discharge was determined from a definite relationship between the specific gravity of the gasoline (0.75) and water (unity or 1). Inasmuch as the gasoline now has lower specific gravity, say 0.74 (60° A.P.I.), the water will occupy some of the vertical distance allotted to the gasoline under the previous specification of 57° A.P.I. This increased height of water will be just enough to overcome the lesser weight of the gasoline and bring about the same pressure (lb. per sq. in.), at the base of the water leg as existed before."

The New Application

The first of the new installations was made to serve one of the cracking plants of the company and consists of three units. Fig. 3 shows a brick box about 12 ft. by 24 ft., through the bottom of which runs the sewer line with block valve just beyond the box. The sewer has an outlet into the box, rising upward in a 3-in. pipe about 10 in. high. When the block valve is closed the material in the sewer, 93 percent water and 7 percent oil, enters the box where an immediate separation occurs with a film of oil forming on top. The water returns to the sewer on the downstream side of the block valve through a 3-in. line about 6 in. high, inside a 6-in. pipe about 12 in. high provided with liberal slots at its lower end. The water, in order to return to the sewer, must rise from the bottom of the brick box and through the annular space between the 6-in. pipe and the 3-in. pipe and enter the sewer through the 3-in. pipe. This brick box is considered the rough separator, or divider. The water leaving this unit tests 0.70 percent oil, or less than 1 oz. per gal., indicating a high degree of separation.

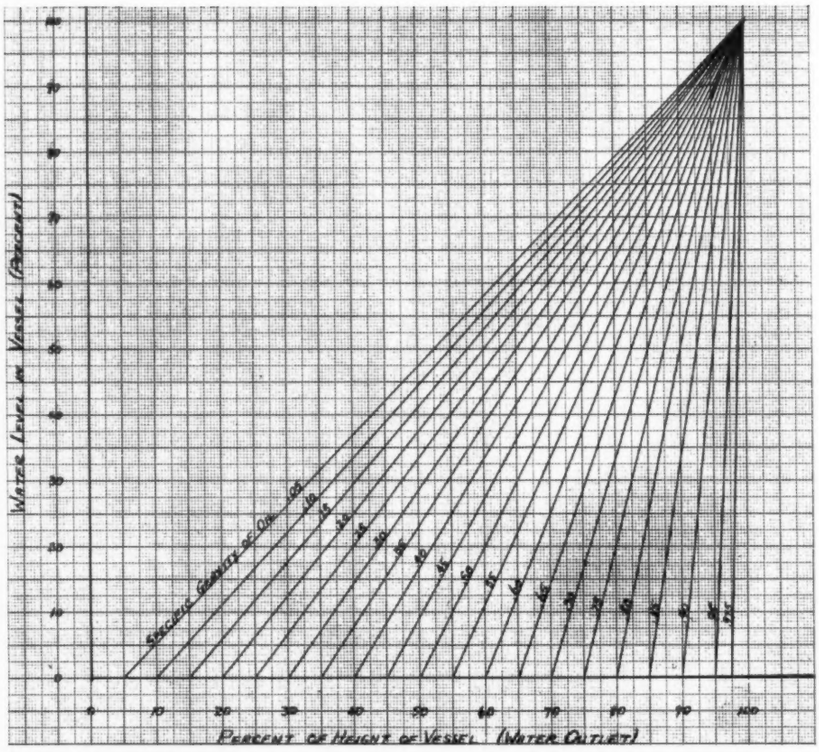
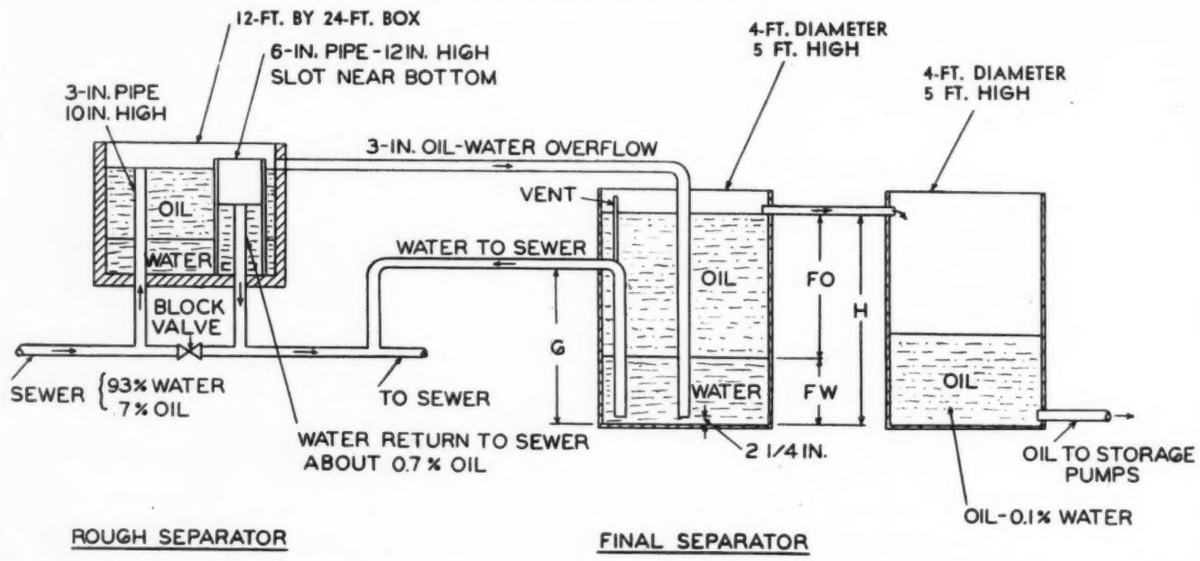


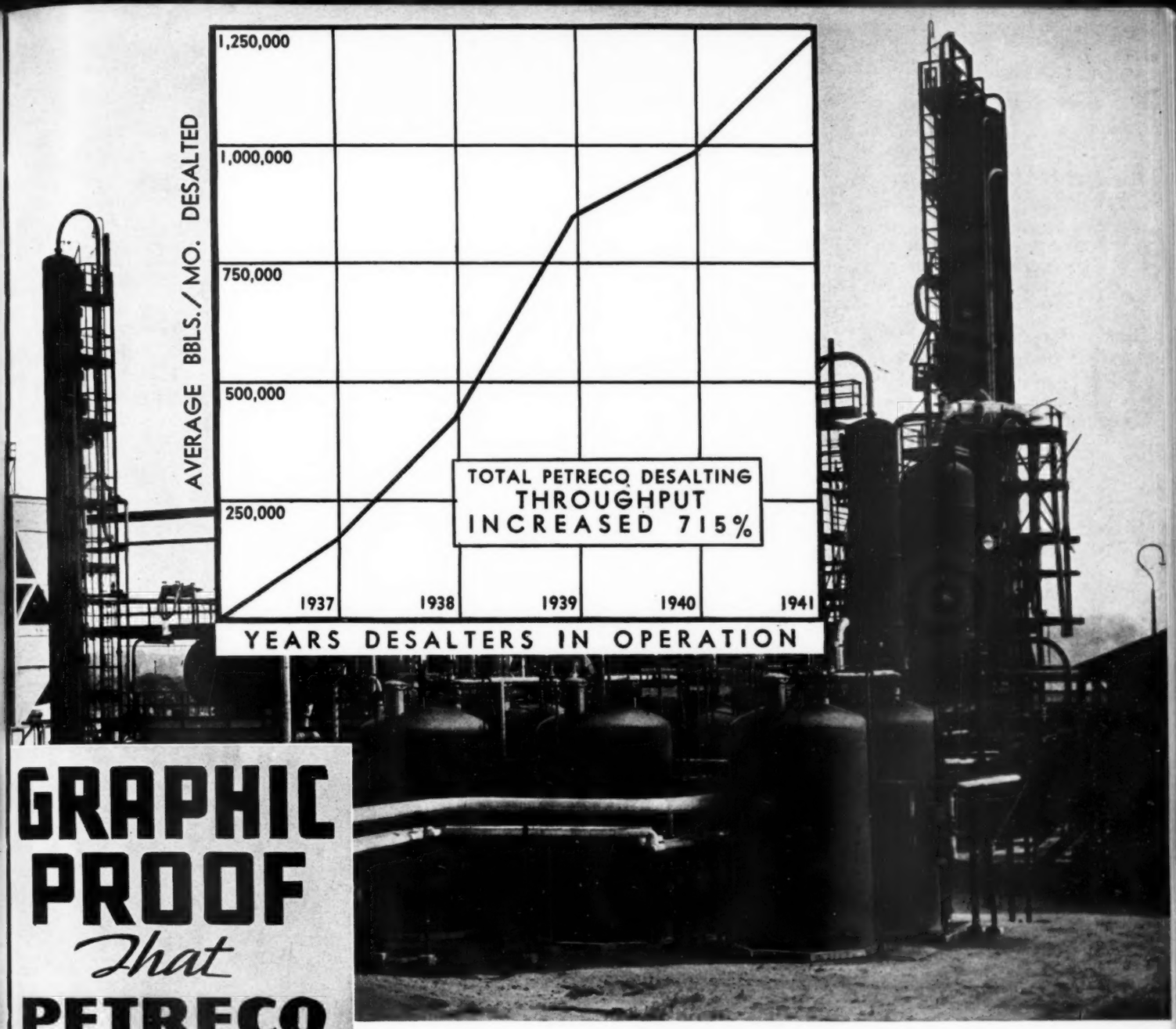
Fig. 4. Nomograph for use in designing oil and water separation unit

The Second Unit

The second unit, or the "true" separator, in this case a vessel 4 ft. in diameter by 5 ft. in height, was salvaged from the junk yard. The overflow of oil and water from the first unit passes from the brick box into the separator vessel through a 3-in. line that goes downward to within about

Fig. 3. Diagram of oil and water separation unit





GRAPHIC PROOF *That* PETRECO ELECTRIC DESALTING INCREASES REFINING EFFICIENCY

In 1937 one of the large eastern refining companies installed a battery of Petreco Electric Desalters in one of their refineries. The benefits of desalting . . . reduced corrosion, plugging and coking . . . longer on-stream time . . . lower maintenance costs . . . so definitely increased the refining efficiency that five additional Petreco installations were made in other of their refineries, ultimately increasing the number of barrels of oil desalted from approximately 170,000 to a million and a quarter barrels per month.

Refinery men can appreciate the significance of the above graphic indication of Petreco Desalting performance. It is obvious that these Petreco Desalters "paid off" in increased refining capacity. Production for war requires the highest efficiency possible . . . and now, more than ever, maximum on-stream time and protection against corrosion and metal losses are vital to refining efficiency. Petreco engineers are always available for an accurate survey of your desalting problem. This service involves no obligation.

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2¼ in. of the bottom of the separator. A gooseneck from the bottom of the separator rises to a point 4 ft. 4 in. above the bottom of the separator and the water flows continuously from the separator through the gooseneck into the sewer. The liquid level in the separator is very close to the top of the vessel and the overflow proceeds into the slop receiver, which. in this case, is also a vessel of about the same size as the close separator. As the function of the slop receiver is only that of an accumulator, its size is not of great importance and can be accommodated to the size of pump available to handle its contents and to convenient pumping periods.

The slop oil in the receiver runs about 0.10 percent water, which is as good as should be expected without use of heat. If the contents of the close separator were maintained at a temperature of about 160°F. the oil might be expected to be practically dry, but this would not be warranted, in all cases, because the contents of the slop receiver normally would not be charged direct to stills but would go to feed stock tanks where further settling out of water would occur.

These devices have served to displace the separation duty formerly done by the large concrete pits available for water storage. Both refineries of the company are now equipped with the new separators, which are reported as functioning perfectly.

Proper Height of Gooseneck

It is obvious that various factors, principally the specific gravity of the oil, governs the height of the gooseneck from the bottom of the vessel. A convenient formula for direct calculation of the height of the gooseneck from the bottom is:

$$\frac{0.434\times\frac{H}{FW}+0.434\times S\times\frac{H}{FO}}{0.434}=G$$

Where:

H = the height in ft. of liquid in the separator; i.e., from the bottom to the oil level outlet

FW = the fraction of the vessel desired to be used for water level

FO = the fraction desired to be used for the oil level

S = the specific gravity of the oil

G = the distance from the bottom of the vessel to the bottom of the top turn of the gooseneck.

It is necessary, of course, to have a vent to atmosphere on top of the gooseneck to serve as a vacuum breaker.

The accompanying nomograph (Fig. 4) has been developed for use with this device and serves as an aid in designing the vessel to fit varying conditions.

☆☆☆

P 623.

Propose Gas Line From South Texas Into Mexico

by Brad M. Smith

FIRST major outlet for the natural gas reserves of Hidalgo County and the Lower Rio Grande Valley, Texas, will be provided by the Border Pipe Line Company of Edinburg and Houston, if the Federal Power Commission approves an application by that company for a permit to export natural gas to Mexico.

If the projected application is granted, the natural gas reserves of the United States will begin to make profitable use of the vast natural resources of the Republic of Mexico at the moment when certain metals have become very vital to the greatest national defense program of all time.

The Border Pipe Line Company proposes to pipe natural gas from the San Salvador field of north central Hidalgo County to the zinc smelter of the American Smelting and Refining Company at La Rosita, Coahuila, Mexico, through a pipe line that will cost an estimated $1,500,000, in addition to making use of an existing natural gas pipe line of 12¾-in. diameter.

The new line will be of 8⅝-in. diameter, all-welded by a new process recently adapted to pipe-line construction by engineers of the El Paso Natural Gas Company. Construction will begin about May 1, according to present plans, at a point south of Mirando City, and the line will be laid to the Rio Grande River to a point south of Laredo. At this point, it will cross the Rio Grande as three 8-in. welded lines to provide maximum protection of the flow by having two extra lines available at all times.

Well pressure in the San Salvador field, discovered, developed, and owned by Gulf States Oil Company of Houston, will deliver gas to the compressor station in Jim Hogg County at a minimum of 250 lb. The compressor station will discharge at 650-720 lb., and the line's capacity at those pressures will be approximately 17,000,000 cu. ft. a day.

Requirements of the smelter at La Rosita are estimated at 10,000,000 cu. ft. a day, but the area in northern Coahuila to be traversed by the line is one of the richest sections of all northern Mexico in respect to undeveloped mineral wealth, and availability of sufficient industrial fuel is expected to result in additional major industrial development for the entire section.

The change-over from coke to natural gas at the La Rosita smelter will release 4000 tons of coke monthly for use in the large steel mills of Monterrey, Mexico, which have not been able to operate at full capacity because of a fuel shortage.

About 39 miles of pipe line will be constructed from the Jim Hogg County compressor station to the Rio Grande, and the line will be 115 miles in length from the Rio Grande River to the La Rosita smelter.

The San Salvador field is said to be one of the world's largest natural gas reservoirs. Latest estimate indicates a reserve of 1,270,000,000,000 cu. ft. of gas. The field already has proved six sands, averaging 40 ft. in thickness, from 6700 to 7900 ft., the principal proved sand being at about 7300 ft.

The deepest sand in the field has been logged at 8050-8700 ft., but its bottom-hole closed-in pressure of 4200 lb. is so great that no accurate test has ever been run. The extremely high pressure thus far has prevented the drilling of a well through the lower sand, several tests having been wrecked. Greatest drilling depth ever reached in either the La Blanca or San Salvador fields, separated by only three miles, was 8886 ft., and the pressure wrecked the hole. That depth in the La Blanca field was comparable to the bottom of the Gulf States' Cardenas No. 2 in the San Salvador field, the 8700-ft. hole.

All sands in the San Salvador field are thick basal Frio sands. Only very brief drill stem tests were ever run in the high-pressure 8000-ft. sand, and operators estimated that a well completed in that sand would produce at a minimum rate of 200,000,000 cu. ft. a day on open flow.

The compressor station on the proposed line would contain two 400-hp. and one 300-hp. vertical units.

☆☆☆

THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT No. 58

THE tables on the following pages are designed to save time and effort for the technician, and to assist the practical field or plant worker to solve problems commonly encountered in routine work. They are not intended nor expected to supplant technical training and make every man his own designer. Most of the tables can be understood and applied by anyone acquainted with the simple fundamentals of mathematics.

For the convenience of readers who wish to refer to the tables, each page carries in the upper right corner an index number that classifies the table according to subject matter.

All petroleum engineering literature may be indexed for reference according to the Dewey Decimal System as modified and extended for the petroleum industry by L. C. Uren, professor of petroleum engineering at the University of California. When classified according to these index numbers the material follows in a logical sequence and falls into several natural divisions, as illustrated by the following outline:

Nos. P000-P399—General
Nos. P400-P499—Drilling
Nos. P500-P599—Production
Nos. P600-P699—Transportation and Storage (includes Pipe Line)
Nos. P700-P799—Refining, including
Nos. P770-P799—Natural Gasoline, which may be classifed in a separate division (as shown here) if of special interest to the user

To aid the reader in using the Decimal System, a subject index arranged alphabetically has been published, and is available at a cost of 50 cents per copy from *The Petroleum Engineer*, P. O. Box 1589, Dallas, Texas.

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DRILLED HOLE SURVEY DATA PER 100 FT. OF DEPTH

Deg. of drift from vertical	Horizontal drift in ft.	Depth loss in ft.	True depth of hole in ft.	Deg. of drift from vertical	Horizontal drift in ft.	Depth loss in ft.	True depth of hole in ft.
32°	52.99	15.19	84.81	47°	73.14	31.80	68.20
32° 15′	53.36	15.43	84.57	47° 30′	73.73	32.44	67.56
32° 30′	53.73	15.66	84.34				
32° 45′	54.10	15.90	84.10	48°	74.31	33.09	66.91
				48° 30′	74.90	33.74	66.26
33°	54.46	16.13	83.87				
33° 15′	54.83	16.37	83.63	49°	75.47	34.39	65.61
33° 30′	55.19	16.61	83.39	49° 30′	76.04	35.05	64.95
33° 45′	55.56	16.85	83.15				
				50°	76.60	35.72	64.28
34°	55.92	17.10	82.90	50° 30′	77.16	36.39	63.61
34° 15′	56.28	17.34	82.66				
34° 30′	56.64	17.59	82.41	51°	77.72	37.07	62.93
34° 45′	57.00	17.83	82.17	51° 30′	78.26	37.75	62.25
35°	57.36	18.08	81.92	52°	78.80	38.43	61.57
35° 15′	57.72	18.34	81.66	52° 30′	79.34	39.12	60.88
35° 30′	58.07	18.59	81.41				
35° 45′	58.43	18.84	81.16	53°	79.86	39.82	60.18
				53° 30′	80.39	40.52	59.48
36°	58.78	19.10	80.90				
36° 15′	59.13	19.36	80.64	54°	80.90	41.22	58.78
36° 30′	59.48	19.61	80.39	54° 30′	81.41	41.93	58.07
36° 45′	59.83	19.87	80.13				
				55°	81.92	42.64	57.36
37°	60.18	20.14	79.86	55° 30′	82.41	43.36	56.64
37° 15′	60.53	20.40	79.60				
37° 30′	60.88	20.66	79.34	56°	82.90	44.08	55.92
37° 45′	61.22	20.93	79.07	56° 30′	83.39	44.81	55.19
38°	61.57	21.20	78.80	57°	83.87	45.54	54.46
38° 15′	61.91	21.47	78.53	57° 30′	84.34	46.27	53.73
38° 30′	62.25	21.74	78.26				
38° 45′	62.59	22.01	77.99	58°	84.81	47.01	52.99
				58° 30′	85.26	47.75	52.25
39°	62.93	22.28	77.72				
39° 15′	63.27	22.56	77.44	59°	85.72	48.50	51.50
39° 30′	63.61	22.84	77.16	59° 30′	86.16	49.25	50.75
39° 45′	63.94	22.12	76.88				
				60°	86.60	50.00	50.00
40°	62.28	23.40	76.60	60° 30′	87.04	50.76	49.24
40° 15′	64.61	23.68	76.32				
40° 30′	64.95	23.96	76.04	61°	87.46	51.52	48.48
40° 45′	65.28	24.24	75.76	61° 30′	87.88	52.28	47.72
41°	65.61	24.53	75.47	62°	88.30	53.05	46.95
41° 15′	65.94	24.82	75.18	62° 30′	88.70	53.82	46.18
41° 30′	66.26	25.10	74.90				
41° 45′	66.59	25.39	74.61	63°	89.10	54.60	45.40
				63° 30′	89.49	55.38	44.62
42°	66.91	25.69	74.31				
42° 15′	67.24	25.98	74.02	64°	89.88	56.16	43.84
42° 30′	67.56	26.27	73.73	64° 30′	90.26	56.95	43.05
42° 45′	67.88	26.57	73.43				
				65°	90.63	57.74	42.26
43°	68.20	26.86	73.14	65° 30′	91.00	58.53	41.47
43° 15′	68.52	27.16	72.84				
43° 30′	68.84	27.46	72.54	66°	91.36	59.33	40.67
43° 45′	69.15	27.76	72.24	66° 30′	91.71	60.12	39.88
44°	69.47	28.07	71.93	67°	92.05	60.93	39.07
44° 15′	69.78	28.37	71.63	67° 30′	92.39	61.73	38.27
44° 30′	70.09	28.67	71.33				
44° 45′	70.40	28.98	71.02	68°	92.72	62.54	37.46
				68° 30′	93.04	63.35	36.65
45°	70.71	29.29	70.71				
45° 30′	71.33	29.91	70.09	69°	93.36	64.16	35.84
				69° 30′	93.67	64.98	35.02
46°	71.93	30.54	69.46				
46° 30′	72.54	31.16	68.84	70°	93.97	65.80	34.20
				70° 30′	94.26	66.62	33.38

FIT...for the job ahead

In the battle of production, *as on the battlefield,* every Hyatt Roller Bearing is built to give a good account of itself.

Those who make, *and those who use,* the machines of war have welcomed Hyatt ability to stand up, unflinchingly, under high speeds, heavy loads and steady going.

Hyatt is proud of its part in the fight for Victory . . . glad to contribute its fifty years' experience in making better bearings . . . and will be in there serving "for the duration"... and thereafter!

Hyatt Bearings Division, General Motors Corporation, Harrison, New Jersey.

THIS IS THE 50TH YEAR OF HYATT ROLLER BEARINGS

SQUARE ROOTS OF WHOLE NUMBERS

	0	1	2	3	4	5	6	7	8	9
500	22.361	22.383	22.405	22.428	22.450	22.472	22.494	22.517	22.539	22.561
510	22.583	22.605	22.627	22.650	22.672	22.694	22.716	22.738	22.760	22.782
520	22.804	22.825	22.847	22.869	22.891	22.913	22.935	22.956	22.978	23.000
530	23.022	23.043	23.065	23.087	23.108	23.130	23.152	23.173	23.195	23.216
540	23.238	23.259	23.281	23.302	23.324	23.345	23.367	23.388	23.409	23.431
550	23.452	23.473	23.495	23.516	23.537	23.558	23.580	23.601	23.622	23.643
560	23.664	23.685	23.707	23.728	23.749	23.770	23.791	23.812	23.833	23.854
570	23.875	23.896	23.917	23.937	23.958	23.979	24.000	24.021	24.042	24.062
580	24.083	24.104	24.125	24.145	24.166	24.187	24.207	24.228	24.249	24.269
590	24.290	24.310	24.331	24.352	24.372	24.393	24.413	24.434	24.454	24.474
600	24.495	14.515	24.536	24.556	24.576	24.597	24.617	24.673	24.658	24.678
610	24.698	24.718	24.739	24.759	24.779	24.799	24.819	24.839	24.860	24.870
620	24.900	24.920	24.940	24.960	24.980	25.000	25.020	25.040	25.060	25.080
630	25.100	25.120	25.140	25.159	25.179	25.199	25.219	25.239	25.259	25.278
640	25.298	25.318	25.338	25.357	25.377	25.397	25.417	25.436	25.456	25.475
650	25.495	25.515	25.534	25.554	25.573	25.593	25.613	25.632	25.652	25.671
660	25.690	25.710	25.729	25.749	25.768	25.788	25.807	25.826	25.846	25.865
670	25.884	25.904	25.923	25.942	25.962	25.981	26.000	26.019	26.038	26.058
680	26.077	26.096	26.115	26.134	26.153	26.173	26.192	26.211	26.230	26.249
690	26.268	26.287	26.306	26.325	26.344	26.363	26.382	26.401	26.420	26.439
700	26.458	26.476	26.495	26.514	26.533	26.552	26.571	26.589	26.608	26.627
710	26.646	26.665	26.683	26.702	26.721	26.739	26.758	26.778	26.796	26.814
720	26.833	26.851	26.870	26.889	26.907	26.926	26.944	26.963	26.981	27.000
730	27.019	27.037	27.056	27.074	27.092	27.111	27.129	27.148	27.166	27.185
740	27.203	27.221	27.240	27.258	27.276	27.295	27.313	27.331	27.350	27.368
750	27.386	27.404	27.423	27.441	27.459	27.477	27.495	27.514	27.532	27.550
760	27.568	27.586	27.604	27.622	27.641	27.659	27.677	27.695	27.713	27.731
770	27.749	27.767	27.785	27.803	27.821	27.839	27.857	27.875	27.893	27.911
780	27.928	27.946	27.964	27.982	28.000	28.018	28.036	28.054	28.071	28.089
790	28.107	28.125	28.124	28.160	28.178	28.196	28.213	28.231	28.249	28.267
800	28.284	28.302	28.320	28.337	28.355	28.373	28.390	28.408	28.425	28.443
810	28.461	28.478	28.496	28.513	28.531	28.548	28.566	28.583	28.601	28.618
820	28.636	28.653	28.671	28.688	28.705	28.723	28.740	28.758	28.775	28.792
830	28.810	28.827	28.844	28.862	28.879	28.896	28.914	28.931	28.948	28.966
840	28.983	29.000	29.017	29.034	29.052	29.069	29.086	29.103	29.120	29.138
850	29.155	29.172	29.189	29.206	29.223	29.240	29.257	29.275	29.292	29.309
860	29.326	29.343	29.360	29.377	29.394	29.411	29.428	29.445	29.462	29.479
870	29.496	29.513	29.530	29.547	29.563	29.580	29.597	29.614	29.631	29.648
880	29.665	29.682	29.698	29.715	29.732	29.749	29.766	29.783	29.799	29.816
890	29.833	29.850	29.866	29.883	29.900	29.917	29.933	29.950	29.967	29.983
900	30.000	30.017	30.033	30.050	30.067	30.083	30.100	30.116	30.133	30.150
910	30.166	30.183	30.199	30.216	30.232	30.249	30.265	30.282	30.299	30.315
920	30.332	30.348	30.364	30.381	30.397	30.414	30.430	30.447	30.463	30.480
930	30.496	30.512	30.529	30.545	30.561	30.578	30.594	30.610	30.627	30.643
940	30.659	30.676	30.692	30.708	30.725	30.741	30.757	30.773	30.790	30.806
950	30.822	30.838	30.855	30.871	30.887	30.903	30.919	30.935	30.952	30.968
960	30.984	31.000	31.016	31.032	31.048	31.064	31.081	31.097	31.113	31.129
970	31.145	31.161	31.177	31.193	31.209	31.225	31.241	31.257	31.273	31.289
980	31.305	31.321	31.337	31.353	31.369	31.385	31.401	31.417	31.432	31.448
990	31.464	31.480	31.496	31.512	31.528	31.544	31.559	31.575	31.591	31.607

Here's the Efficient Way to Make Your Present Engines *last longer*

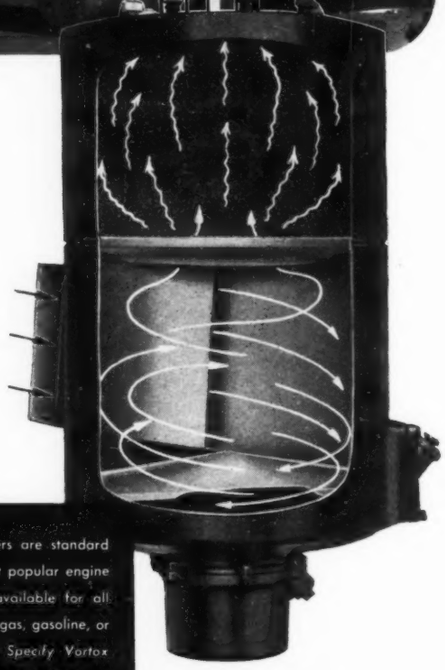
Today replacement parts are at a premium and repairs are more costly than ever before, so it's essential that you protect your oil field engines in every way you can . . . that you eliminate costly overhauls and keep your present equipment going without delays.
And one of the most effective ways you can do this is to make sure that every engine you operate—on pumping stations, compressors, tractors, and trucks—is equipped with the leading air cleaner of the industry—VORTOX! These Cleaners give you maximum protection by preventing dust and dirt from reaching vital engine parts—thus they cut down on engine wear, reduce replacement needs, and maintain peak engine performance.

SIMPLE, MAINTENANCE-FREE—Vortox Cleaners have no cloth filters which may clog and require frequent service or replacement. Because of the self-washing action of the oil as it drains from the filter to the sump, effectiveness of the filter is constantly maintained, and a periodic change of oil in the reservoir *is the only maintenance needed!*

DEPENDABLE PROTECTION—Severe dust loads or adverse operating conditions will not reduce the efficient, trouble-free performance of a Vortox. "Stop and go" operation or fluctuating speeds—they're all the same to this unit!

PROVEN EFFICIENCY—Regardless of engine size or service required, there is a Vortox Air Cleaner made to operate efficiently, and to give highest protection against damage to all internal parts.

VORTOX MANUFACTURING CO. • CLAREMONT, CALIF.



Vortox Air Cleaners are standard equipment on most popular engine makes, and are available for all sizes and types of gas, gasoline, or Diesel equipment. *Specify Vortox for complete engine protection!*

VORTOX

OIL TYPE SELF-WASHING AIR CLEANER

CORRESPONDING DIFFERENTIALS—EQUAL FLOWS

FOR 4-IN. FLANGES—Size of orifice plate to be installed, in.

Size of Orifice plate in use, in.	¼	⅜	½	⅝	¾	⅞	1	1¼	1½	1¾	2	2¼	2½	2¾	3
¼	1.0	0.20	0.06	0.03	0.01										
⅜	5.1	1.0	0.32	0.13	0.06	0.03									
½	16.0	3.2	1.0	0.41	0.20	0.11	0.06	0.03	0.01						
⅝	39.0	7.7	2.4	1.0	0.48	0.26	0.15	0.06	0.03						
¾	81.0	16.0	5.1	1.5	1.0	0.54	0.32	0.13	0.06	0.03					
⅞		30.0	9.4	2.9	1.8	1.0	0.59	0.24	0.12	0.06	0.04	0.02			
1		50.0	16.0	4.9	3.2	1.7	1.0	.41	0.20	0.11	0.06	0.04	0.02		
1¼			39.0	12.0	7.7	4.2	2.4	1.0	0.48	0.26	0.15	0.09	0.05	0.03	0.02
1½			81.0	25.0	16.0	8.6	5.1	2.1	1.0	0.54	0.31	0.18	0.11	0.07	0.04
1¾				46.0	30.0	16.0	9.4	3.8	1.8	1.0	0.57	0.33	0.20	0.12	0.08
2					52 0	28.0	17.0	6.8	3.3	1.8	1.0	0.59	0.35	0.21	0.13
2¼						44.0	28.0	11.0	5.6	3.0	1.7	1.0	0.60	0.36	0.23
2½							47.0	19.0	9.3	5.0	2.9	1.7	1.0	0.61	0.38
2¾								32.0	15.0	8.2	4.7	2.8	1.6	1.0	0.62
3								51.0	25.0	13.0	7.5	4.4	2.7	1.6	1.0

FOR 6-IN. FLANGES—Size of orifice plate to be installed, in.

Size of Orifice plate in use, in.	¾	⅞	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3½	4	4½	
⅜	0.06	0.03													
½	0.20	0.11	0.06	0.03											
⅝	0.48	0.26	0.15	0.06	0.03										
¾	1.0	0.54	0.32	0.13	0.06	0.03									
⅞	1.8	1.0	0.59	0.24	0.12	0.06	0.04	0.02							
1	3.2	1.7	1.0	0.41	0.20	0.11	0.06	0.04	0.03						
1¼	7.7	4.2	2.4	1.0	0.48	0.26	0.15	0.10	0.06	0.04	0.03				
1½	16.0	8.6	5.1	2.1	1.0	0.54	0.32	0.20	0.13	0.09	0.06	0.03			
1¾	30.0	16.0	9.4	3.8	1.8	1.0	0.59	0.37	0.21	0.16	0.11	0.06	0.03		
2	51.0	27.0	16.0	2.6	3.2	1.7	1.0	0.62	0.41	0.28	0.19	0.09	0.05	0.03	
2¼		44.0	26.0	10.0	5.1	2.7	1.6	1.0	0.66	0.44	0.31	0.15	0.08	0.04	
2½			39.0	16.0	7.7	4.2	2.4	1.5	1.0	0.63	0.47	0.23	0.12	0.06	
2¾			58.0	24.0	11.0	6.2	3.6	2.3	1.5	1.0	0.69	0.34	0.17	0.09	
3				34 0	17.0	8.9	5.2	3.3	2.1	1.4	1.0	0.50	0.25	0.13	
3½				69.0	33 0	18.0	11.0	6.6	4.3	2.9	2.0	1.0	0.51	0.27	
4					65.0	35.0	21.0	13.0	8.5	5.8	4.0	2.0	1.0	0.53	
4½						67.0	39.0	25.0	16.0	11.0	7.5	3.7	1.9	1.0	

FOR 8-IN. FLANGES—Size of orifice plate to be installed, in.

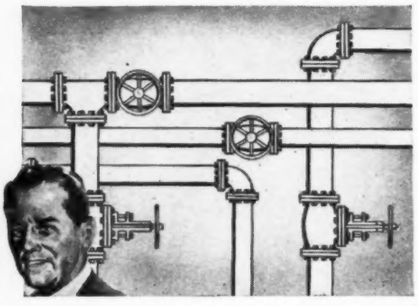
Size of Orifice plate in use, in.	1	1¼	1½	1¾	2	2¼	2½	2¾	3	3½	4	4½	5	5½	6
1	1.0	0.41	0.20	0.11	0.06	0.04	0.03	0.02							
1¼	2.4	1.0	0.48	0.26	0.15	0.10	0.06	0.04	0.03						
1½	5.1	2.1	1.0	0.54	0.32	0.20	0.13	0.09	0.06	0.03					
1¾	9.4	3.8	1.8	1.0	0.59	0.37	0.24	0.16	0.12	0.06	0.04				
2	16.0	6.6	3.2	1.7	1.0	0.62	0.41	0.28	0.20	0.11	0.06	0.04			
2¼	26.0	10.0	5.1	2.7	1.6	1.0	0.66	0.45	0.32	0.17	0.10	0.06	0.03		
2½	39.0	16.0	7.7	4.2	2.4	1.5	1.0	0.68	0.48	0.26	0.15	0.09	0.05	0.03	
2¾	57.0	23.0	11.0	6.1	3.6	2.2	1.5	1.0	0.71	0.38	0.22	0.13	0.08	0.05	0.03
3	81.0	33.0	16.0	8.6	5.1	3.2	2.1	1.4	1.0	0.54	0.31	0.18	0.11	0.07	0.04
3½		62.0	30.0	16.0	9.4	5.9	3.8	2.6	1.8	1.0	0.57	0.33	0.20	0.12	0.08
4			53 0	45.0	16.0	10 0	6.8	4.6	3.3	1.8	1.0	0.59	0.35	0.21	0.13
4½			89.0	48.0	28.0	18 0	12.0	7.9	5.6	3.0	1.7	1.0	0.60	0.36	0.23
5				80.0	47.0	29.0	19.0	13.0	9.3	5.0	2.9	1.7	1.0	0.61	0.38
5½					77.0	48.0	32.0	22.0	15.0	8.2	4.7	2.7	1.6	1.0	0.62
6						77.0	51.0	35.0	25.0	13.0	7.5	4.4	2.6	1.6	1.0

Example: The highest differential reading on a 4 in. by 2 in. orifice plate is 10 in. on a 100-in. chart. It is desired to install a 4 in. by 1½ in. orifice plate. What will be the differential on the chart with the 4 in. by 1½ in. orifice plate installed.

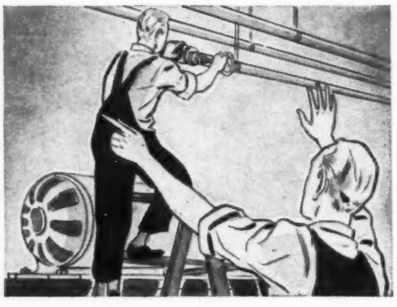
In the 4 in. flange section of the table find the 2-in. orifice size. Under the 1½-in. orifice size, where the columns intersect find 3.3. Multiply by 10 and the new differential reading is 33 in. for the 4 in. by 1½ in. plate.

These "Pointers" Made a Tough Training Job Easier!

❶ With the plant running 168 hours a week, we needed more and better maintenance—day and night. On piping, for example, you can't get away with part-time maintenance and keep production lines running smoothly. It's too important!

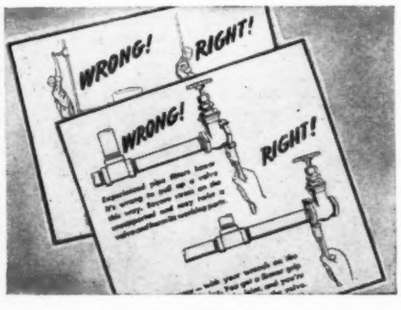


❷ Soon enough, we found valves and fittings would have to be handled with unusual care to get every last bit of service out of them. They're vital equipment, and with all the demands of war, deliveries of replacements were being slowed up.



❸ Sure, we put on more "maintenance" men, but many had never handled a wrench before. We had to start from scratch in training them. In the past, our veteran crews had the time to teach apprentices, but that was "before Pearl Harbor."

❹ You know that piping maintenance is a specialized job. But it's knowing the "kinks" of the trade that makes the difference between good and bad installations. They help speed-up the work as well as step-up efficiency of pipe lines.



❺ We had to teach these men the "rights and wrongs" of piping make-up. We had to be sure they knew enough about valves of all types, and when and where to use them. Good piping depends a lot on using the right equipment.

HOW TO KEEP YOUR PLANT GOING WITHOUT INTERRUPTION!
HELPFUL HINTS ON CHOOSING VALVES FOR BETTER PIPING SERVICE
TIPS ON VALVE TRIM
TO HELP KEEP PIPING ON THE JOB

❻ These Crane Shop Bulletins made a tough training job easier. They're full of valuable piping pointers. We used them in employee training classes; posted them in maintenance shops; passed them among the men. Even the old-timers use them! **And listen, any plant can get these Bulletins free—through the local Crane Representative.**

CRANE

CRANE CO., GENERAL OFFICES:
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VALVES • FITTINGS • PIPE
PLUMBING • HEATING • PUMPS

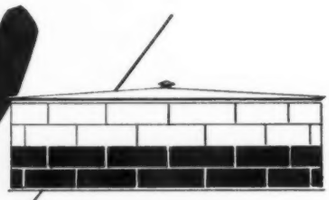
NATION-WIDE SERVICE THROUGH BRANCHES AND WHOLESALERS IN ALL MARKETS

GRAVITY OF DRY OIL IN OIL-WATER MIXTURES, DEG. A.P.I.

Gravity of "wet" oil, deg. A.P.I.	Percent water in mixture									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
55.0	55.06	55.12	55.18	55.24	55.31	55.36	55.42	55.48	55.54	55.60
.1	.16	.22	.28	.34	.41	.46	.52	.58	.64	.70
.2	.26	.32	.38	.44	.51	.56	.62	.68	.74	.80
.3	.36	.42	.48	.54	.61	.66	.72	.78	.84	.90
.4	.46	.52	.58	.64	.71	.76	.82	.88	.94	56.01
55.5	55.56	55.62	55.68	55.74	55.81	55.86	55.92	55.98	56.04	56.11
.6	.66	.72	.78	.84	.91	.96	56.02	56.08	.14	.21
.7	.75	.82	.88	.94	56.01	56.06	.12	.18	.24	.31
.8	.85	.91	.98	56.04	.10	.16	.22	.28	.35	.41
.9	.95	56 01	56.08	.14	.20	.26	.32	.38	.44	.51
56.0	56.05	56.11	56.18	56.24	56.31	56.36	56.42	56.48	56.55	56.61
.1	.15	.21	.28	.34	.41	.46	.52	.59	.65	.71
.2	.25	.31	.38	.44	.51	.56	.62	.69	.75	.81
.3	.35	.41	.48	.54	.61	.66	.72	.79	.85	.91
.4	.45	.51	.58	.64	.71	.76	.83	.89	.95	57.01
56.5	56.55	56.61	56.68	56.74	56.81	56.86	56.93	56.99	57.05	57.11
.6	.65	.71	.78	.84	.91	.96	57.03	57.09	.15	.22
.7	.75	.81	.88	.94	57.01	57.07	.13	.19	.26	.32
.8	.85	.91	.98	57.04	.11	.17	.23	.29	.36	.42
.9	.95	57.02	57.08	.14	.21	.27	.33	.40	.46	.52
57.0	57.05	57.12	57.18	57.24	57.31	57.37	57.43	57.50	57.56	57.63
.1	.15	.22	.28	.34	.41	.47	.53	.60	.66	.73
.2	.25	.32	.38	.44	.52	.57	.64	.70	.77	.83
.3	.36	.42	.48	.55	.62	.67	.74	.80	.87	.93
.4	.46	.52	.58	.65	.72	.78	.84	.90	.97	58.03
57.5	57.56	57.62	57.69	57.75	57.82	57.88	57.94	58.01	58.07	58.14
.6	.66	.72	.79	.85	.92	.98	.04	.11	.17	.24
.7	.76	.82	.89	.95	58.02	58.08	.15	.21	.28	.34
.8	.86	.93	.99	58.05	.13	.18	.25	.31	.38	.45
.9	.96	58.03	58.09	.16	.23	.29	.35	.42	.48	.55
58.0	58.06	58.13	58.19	58.26	58.33	58.39	58.45	58.52	58.59	58.65
.1	.17	.23	.30	.36	.43	.49	.56	.62	.69	.76
.2	.27	.33	.40	.46	.54	.59	.66	.73	.79	.86
.3	.37	.44	.50	.57	.64	.70	.76	.83	.90	.96
.4	.47	.54	.60	.67	.74	.80	.87	.93	**59.00**	59.07
58.5	58.57	58.64	58.71	58.77	58.84	58.90	58.97	59.04	59.10	59.17
.6	.68	.74	.81	.87	.95	59.01	59.07	.14	.21	.27
.7	.75	.82	.89	.95	59.02	.08	.15	.22	.28	.35
.8	.86	.92	.99	59.05	.13	.18	.25	.32	.39	.46
.9	.96	59.02	59.09	.16	.23	.29	.36	.42	.49	.56
59.0	59.06	59.13	59.19	59.26	59.33	59.39	59.46	59.53	59.60	59.66
.1	.16	.23	.30	.36	.44	.50	.56	.63	.70	.77
.2	.27	.33	.40	.47	.54	.60	.67	.74	.80	.87
.3	.37	.44	.50	.57	.65	.71	.77	.84	.91	.98
.4	.47	.54	.61	.67	.75	.81	.88	.95	60.01	60.08
59.5	59.58	59.64	59.71	59.78	59.85	59.91	59.98	60.05	60.12	60.19
.6	.65	.72	.79	.86	.93	.99	60.06	.13	.20	.27
.7	.76	.83	.89	.96	60.04	60.10	.16	.23	.30	.37
.8	.86	.93	**60.00**	60.06	.14	.20	.27	.34	.41	.48
.9	.96	60.03	.10	.17	.24	.31	.37	.44	.51	.58

Gravity of dry oil in oil water mixture, deg. A.P.I. with percent water in mixture less than one suggested by R. W. Miller, Phillips Petroleum Company, Oklahoma City, Oklahoma.

Save!



STEEL and OIL

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– AND WAR PLANES

Tank owners can effectively **serve the War Effort** by the adoption of proven **Substitutes** for STEEL REPLACEMENTS and the **Elimination** of OIL LOSSES.

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Seals Leaky Tank Bottoms
Makes Leaky Tank Tops Vapor Tight
Prevents and Stops Corrosion
Minimizes Evaporation and Fire Losses

RESULTS

Revitalizing and **Maintaining** tankage with these materials and by "Natasco" Methods not only makes **Profits** out of **Losses** for the tank owner but **Conserves** and makes available for our **Government** those vital war materials **STEEL and OIL.**

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Protection For THRIFTY Tank Owners
"NATASCO"
CONSERVES Oil and Equipment Makes for Profit

TANK SEAL PRODUCTS COMPANY

P. O. BOX 2412 • TELEPHONE 4-2467 • TULSA, OKLAHOMA, U. S. A.

W. G. CONSTRUCTION COMPANY HOBBS, N. M. { REPRESENTATIVES } REFINERY SUPPLY COMPANY OF CALIF. LOS ANGELES, CALIF.

Static Press.
1400-1495 lb.

PRESSURE EXTENSIONS—ORIFICE METER CALCULATIONS

Differential pressure, in. of water	Static pressure, lb. per sq. in., ga.																				
	1400	1405	1410	1415	1420	1425	1430	1435	1440	1445	1450	1455	1460	1465	1470	1475	1480	1485	1490	1495
2	53.19	53.28	53.38	53.48	53.56	53.66	53.75	53.85	53.94	54.03	54.13	54.21	54.31	54.40	54.50	54.58	54.68	54.76	54.86	54.95
4	75.24	75.36	75.50	75.64	75.76	75.90	76.02	76.16	76.30	76.42	76.56	76.68	76.82	76.94	77.08	77.20	77.34	77.46	77.60	77.72
6	92.13	92.28	92.45	92.62	92.77	92.94	93.09	93.26	93.43	93.58	93.75	93.89	94.07	94.21	94.38	94.53	94.70	94.85	95.02	95.17
8	106.4	106.6	106.8	107.0	107.1	107.3	107.5	107.7	107.9	108.1	108.3	108.4	108.6	108.8	109.0	109.2	109.4	109.5	109.7	109.9
10	119.0	119.1	119.4	119.6	119.8	120.0	120.2	120.4	120.6	120.8	121.0	121.2	121.5	121.6	121.9	122.1	122.3	122.5	122.7	122.9
12	130.3	130.5	130.8	131.0	131.2	131.5	131.7	131.9	132.2	132.4	132.6	132.8	133.1	133.3	133.5	133.7	134.0	134.2	134.4	134.6
14	140.8	141.0	141.3	141.5	141.7	142.0	142.2	142.5	142.8	143.0	143.2	143.5	143.7	144.0	144.2	144.4	144.7	144.9	145.2	145.4
16	150.5	150.7	151.0	151.3	151.5	151.8	152.0	152.3	152.6	152.8	153.1	153.4	153.6	153.9	154.2	154.4	154.7	154.9	155.2	155.4
18	159.6	159.9	160.2	160.5	160.7	161.0	161.3	161.6	161.9	162.1	162.4	162.7	163.0	163.2	163.5	163.8	164.1	164.3	164.6	164.9
20	168.2	168.5	168.8	169.1	169.4	169.7	170.0	170.3	170.6	170.9	171.2	171.5	171.8	172.0	172.3	172.6	172.9	173.2	173.5	173.8
21	172.4	172.7	173.0	173.3	173.6	173.9	174.2	174.5	174.8	175.1	175.4	175.7	176.0	176.3	176.6	176.9	177.2	177.5	177.8	178.1
22	176.4	176.7	177.0	177.4	177.7	178.0	178.3	178.6	178.9	179.2	179.5	179.8	180.1	180.4	180.8	181.0	181.4	181.6	182.0	182.3
23	180.4	180.7	181.0	181.4	181.7	182.0	182.3	182.6	183.0	183.3	183.6	183.9	184.2	184.5	184.8	185.1	185.5	185.7	186.1	186.4
24	184.3	184.6	184.9	185.3	185.6	185.9	186.2	186.6	186.9	187.2	187.5	187.8	188.2	188.5	188.8	189.1	189.4	189.7	190.1	190.4
25	188.1	188.4	188.8	189.1	189.4	189.8	190.1	190.4	190.8	191.1	191.4	191.7	192.1	192.4	192.7	193.0	193.4	193.7	194.0	194.3
26	191.8	192.1	192.5	192.8	193.2	193.5	193.8	194.2	194.5	194.8	195.2	195.5	195.9	196.2	196.5	196.8	197.2	197.5	197.8	198.1
27	195.5	195.8	196.1	196.5	196.8	197.2	197.5	197.9	198.2	198.5	198.9	199.2	199.6	199.9	200.3	200.6	200.9	201.2	201.6	201.9
28	199.1	199.4	199.8	200.1	200.5	200.8	201.1	201.5	201.9	202.2	202.6	202.9	203.3	203.6	204.0	204.3	204.6	205.0	205.3	205.6
29	202.6	202.9	203.3	203.7	204.0	204.4	204.7	205.1	205.4	205.8	206.2	206.5	206.8	207.2	207.5	207.9	208.2	208.6	208.9	209.3
30	206.0	206.4	206.8	207.1	207.5	207.9	208.2	208.6	208.9	209.3	209.7	210.0	210.4	210.7	211.1	211.4	211.8	212.1	212.5	212.8
31	209.5	209.8	210.2	210.6	210.9	211.3	211.6	212.0	212.4	212.8	213.1	213.5	213.9	214.2	214.6	214.9	215.3	215.6	216.0	216.4
32	212.8	213.2	213.6	213.9	214.3	214.7	215.0	215.4	215.8	216.2	216.5	216.9	217.3	217.6	218.0	218.4	218.8	219.1	219.5	219.8
33	216.1	216.5	216.9	217.3	217.6	218.0	218.4	218.8	219.2	219.5	219.9	220.3	220.7	221.0	221.4	221.8	222.2	222.5	222.9	223.3
34	219.4	219.7	220.1	220.5	220.9	221.3	221.6	222.0	222.5	222.8	223.2	223.6	224.0	224.3	224.7	225.1	225.5	225.8	226.2	226.6
35	222.6	222.9	223.3	223.7	224.1	224.5	224.9	225.3	225.7	226.1	226.5	226.8	227.2	227.6	228.0	228.4	228.8	229.1	229.5	229.9
36	225.7	226.1	226.5	226.9	227.3	227.7	228.1	228.5	228.9	229.3	229.7	230.0	230.5	230.8	231.2	231.6	232.0	232.4	232.8	233.2
37	228.8	229.2	229.6	230.1	230.4	230.8	231.2	231.6	232.1	232.4	232.9	233.2	233.6	234.0	234.4	234.8	235.2	235.6	236.0	236.4
38	231.9	232.2	232.7	233.1	233.5	233.9	234.3	234.7	235.2	235.5	236.0	236.3	236.8	237.1	237.6	237.9	238.4	238.7	239.2	239.5
39	234.9	235.3	235.7	236.2	236.6	237.0	237.4	237.8	238.2	238.6	239.1	239.4	239.9	240.2	240.7	241.1	241.5	241.9	242.3	242.7
40	237.9	238.3	238.8	239.2	239.6	240.0	240.4	240.9	241.3	241.7	242.1	242.5	242.9	243.3	243.8	244.1	244.6	245.0	245.4	245.8
41	240.9	241.3	241.7	242.2	242.5	243.0	243.4	243.8	244.3	244.7	245.1	245.5	245.9	246.3	246.8	247.2	247.6	248.0	248.4	248.8
42	243.8	244.2	244.7	245.1	245.5	246.0	246.3	246.8	247.3	247.6	248.1	248.5	248.9	249.3	249.8	250.2	250.6	251.0	251.5	251.9
43	246.7	247.1	247.5	248.0	248.4	248.8	249.2	249.7	250.1	250.5	251.0	251.4	251.9	252.2	252.7	253.1	253.6	254.0	254.4	254.8
44	249.5	249.9	250.4	250.9	251.3	251.7	252.1	252.6	253.0	253.4	253.9	254.3	254.8	255.2	255.6	256.0	256.5	256.9	257.4	257.8
45	252.4	252.8	253.2	253.7	254.1	254.6	255.0	255.4	255.9	256.3	256.8	257.2	257.7	258.1	258.5	258.9	259.4	259.8	260.3	260.7
46	255.1	255.5	256.0	256.5	256.9	257.4	257.8	258.3	258.7	259.1	259.6	260.0	260.5	260.9	261.4	261.8	262.3	262.7	263.1	263.5
47	257.9	258.3	258.8	259.3	259.7	260.2	260.6	261.1	261.6	262.0	262.4	262.9	263.3	263.8	264.2	264.6	265.1	265.5	266.0	266.4
48	260.6	261.0	261.5	262.0	262.4	262.9	263.3	263.8	264.3	264.7	265.2	265.6	266.1	266.5	267.0	267.4	267.9	268.3	268.8	269.2
49	263.3	263.8	264.3	264.7	265.2	265.7	266.1	266.6	267.1	267.5	268.0	268.4	268.9	269.3	269.8	270.2	270.7	271.1	271.6	272.0
50	266.0	266.4	266.9	267.4	267.8	268.3	268.8	269.3	269.8	270.2	270.7	271.1	271.6	272.0	272.5	272.9	273.4	273.9	274.4	274.8
51	268.6	269.1	269.6	270.1	270.5	271.0	271.4	271.9	272.4	272.9	273.4	273.8	274.3	274.7	275.2	275.6	276.1	276.6	277.1	277.5
52	271.3	271.7	272.2	272.7	273.2	273.7	274.1	274.6	275.1	275.5	276.0	276.5	277.0	277.4	277.9	278.3	278.8	279.3	279.8	280.2
53	273.9	274.3	274.8	275.3	275.8	276.3	276.7	277.2	277.7	278.2	278.7	279.1	279.6	280.1	280.6	281.0	281.5	282.0	282.5	282.9
54	276.4	276.9	277.4	277.9	278.3	278.8	279.3	279.8	280.3	280.8	281.3	281.7	282.2	282.7	283.2	283.6	284.1	284.6	285.1	285.5
55	279.0	279.4	280.0	280.5	280.9	281.4	281.9	282.4	282.9	283.4	283.9	284.3	284.8	285.3	285.8	286.3	286.8	287.2	287.7	288.2
56	281.5	282.0	282.5	283.0	283.5	284.0	284.4	285.0	285.5	285.9	286.4	286.9	287.4	287.9	288.4	288.8	289.4	289.8	290.3	290.8
57	284.0	284.5	285.0	285.5	286.0	286.5	287.0	287.5	288.0	288.5	289.0	289.5	290.0	290.4	291.0	291.4	292.0	292.4	292.9	293.4
58	286.5	287.0	287.5	288.0	288.5	289.0	289.5	290.0	290.6	291.0	291.5	292.0	292.5	293.0	293.5	294.0	294.5	295.0	295.5	296.0
59	289.0	289.4	290.0	290.5	291.0	291.5	292.0	292.5	293.0	293.5	294.0	294.5	295.0	295.5	296.0	296.5	297.0	297.5	298.0	298.5
60	291.4	291.9	292.4	293.0	293.4	294.0	294.4	295.0	295.5	296.0	296.5	297.0	297.5	298.0	298.5	299.0	299.5	300.0	300.5	301.0
61	293.8	294.3	294.8	295.4	295.8	296.4	296.9	297.4	298.0	298.4	299.0	299.4	300.0	300.5	301.0	301.5	302.0	302.5	303.0	303.5
62	296.2	296.7	297.2	297.8	298.3	298.8	299.3	299.8	300.4	300.9	301.4	301.9	302.4	302.9	303.5	303.9	304.5	305.0	305.5	306.0
63	298.6	299.1	299.6	300.2	300.7	301.2	301.7	302.2	302.8	303.3	303.8	304.3	304.9	305.3	305.9	306.4	306.9	307.4	308.0	308.4
64	301.0	301.4	302.0	302.6	303.0	303.6	304.1	304.6	305.2	305.7	306.2	306.7	307.3	307.8	308.3	308.8	309.4	309.8	310.4	310.9
65	303.3	303.8	304.3	304.9	305.4	306.0	306.4	307.0	307.6	308.0	308.6	309.1	309.7	310.1	310.7	311.2	311.8	312.2	312.8	313.3
66	305.6	306.1	306.7	307.2	307.7	308.3	308.8	309.4	309.9	310.4	311.0	311.5	312.0	312.5	313.1	313.6	314.2	314.6	315.2	315.7
67	307.9	308.4	309.0	309.6	310.0	310.6	311.1	311.7	312.3	312.7	313.3	313.8	314.4	314.9	315.4	315.9	316.5	317.0	317.6	318.1
68	310.2	310.7	311.3	311.9	312.4	312.9	313.4	314.0	314.6	315.1	315.7	316.2	316.7	317.2	317.8	318.3	318.9	319.4	319.9	320.4
69	312.5	313.0	313.6	314.2	314.7	315.3	315.7	316.3	316.9	317.4	318.0	318.5	319.1	319.6	320.2	320.7	321.2	321.7	322.3	322.8
70	314.8	315.3	315.9	316.4	316.9	317.5	318.0	318.6	319.2	319.7	320.3	320.8	321.4	321.9	322.5	323.0	323.6	324.0	324.6	325.1
71	317.0	317.5	318.1	318.7	319.2	319.8	320.3	320.9	321.5	322.0	322.5	323.1	323.6	324.1	324.7	325.2	325.8	326.3	326.9	327.4
72	319.2	319.7	320.3	320.9	321.4	322.0	322.5	323.1	323.7	324.2	324.8	325.3	325.9	326.4	327.0	327.5	328.1	328.6	329.2	329.7
73	321.4	321.9	322.5	323.1	323.6	324.2	324.8	325.4	326.0	326.5	327.1	327.6	328.2	328.7	329.3	329.8	330.4	330.9	331.5	332.0
74	323.6	324.1	324.7	325.3	325.8	326.4	327.0	327.6	328.2	328.7	329.3	329.8	330.4	330.9	331.5	332.0	332.6	333.2	333.8	334.3
75	325.8	326.3	326.9	327.5	328.0	328.6	329.2	329.8	330.4	330.9	331.5	332.0	332.6	333.2	333.8	334.3	334.9	335.4	336.0	336.5
76	328.0	328.5	329.1	329.7	330.2	330.8	331.4	332.0	332.6	333.1	333.7	334.2	334.9	335.4	336.0	336.5	337.1	337.6	338.3	338.8
77	330.1	330.6	331.3	331.9	332.4	333.0	333.5	334.2	334.8	335.3	335.9	336.4	337.0	337.6	338.2	338.7	339.3	339.9	340.5	341.0
78	332.3	332.8	333.4	334.0	334.6	335.2	335.7	336.3	336.9	337.5	338.1	338.6	339.2	339.8	340.4	340.9	341.5	342.1	342.7	343.2
79	334.4	334.9	335.5	336.1	336.7	337.3	337.8	338.5	339.1	339.6	340.2	340.8	341.4	341.9	342.5	343.1	343.7	344.2	344.9	345.4
80	336.5	337.0	337.6	338.3	338.8	339.4	340.0	340.6	341.2	341.8	342.4	342.9	343.5	344.1	344.7	345.2	345.9	346.4	347.0	347.6
82	340.6	341.2	341.8	342.5	343.0	343.6	344.2	344.8	345.4	346.0	346.6	347.2	347.8	348.3	349.0	349.5	350.2	350.7	351.3	351.9
84	344.8	345.3	346.0	346.6	347.2	347.8	348.4	349.0	349.6	350.2	350.8	351.4	352.0	352.6	353.2	353.8	354.4	355.0	355.6	356.2
86	348.9	349.4	350.1	350.7	351.3	351.9	352.5	353.2	353.8	354.4	355.0	355.6	356.2	356.8	357.4	358.0	358.6	359.2	359.8	360.4
88	352.9	353.5	354.1	354.8	355.4	356.0	356.6	357.2	357.9	358.4	359.1	359.7	360.3	360.9	361.5	362.1	362.8	363.3	364.0	364.5
90	356.9	357.5	358.1	358.8	359.4	360.0	360.6	361.3	361.9	362.5	363.2	363.7	364.4	365.0	365.6	366.2	366.9	367.4	368.1	368.7
92	360.9	361.4	362.1	362.8	363.3	364.0	364.6	365.3	365.9	366.5	367.2	367.8	368.4	369.0	369.7	370.3	370.9	371.5	372.2	372.7
94	364.7	365.3	366.0	366.7	367.2	367.9	368.5	369.2	369.9	370.4	371.1	371.7	372.4	373.0	373.6	374.2	374.9	375.5	376.2	376.7
96	368.6	369.2	369.9	370.6	371.1	371.8	372.4	373.1	373.8	374.4	375.1	375.7	376.3	376.9	377.6	378.2	378.9	379.5	380.2	380.8
98	372.4	373.0	373.7	374.4	375.0	375.7	376.3	377.0	377.6	378.2	378.9	379.5	380.2	380.8	381.5	382.1	382.8	383.4	384.1	384.7
100	376.2	376.8	377.5	378.2	378.8	379.5	380.1	380.8	381.5	382.1	382.8	383.4	384.1	384.7	385.4	386.0	386.7	387.3	388.0	388.6

NOTE: Values given in body of table are products of the square roots of the static and differential pressures in lb. per sq. in., abs., and inches of water respectively.

Absolute pressures are based on atmospheric pressure of 15 lb. per sq. in.

Table has been condensed to serve field men in approximating meter readings, intermediate readings for accurate measurements may be obtained from pressure extension books, usually available in district offices.

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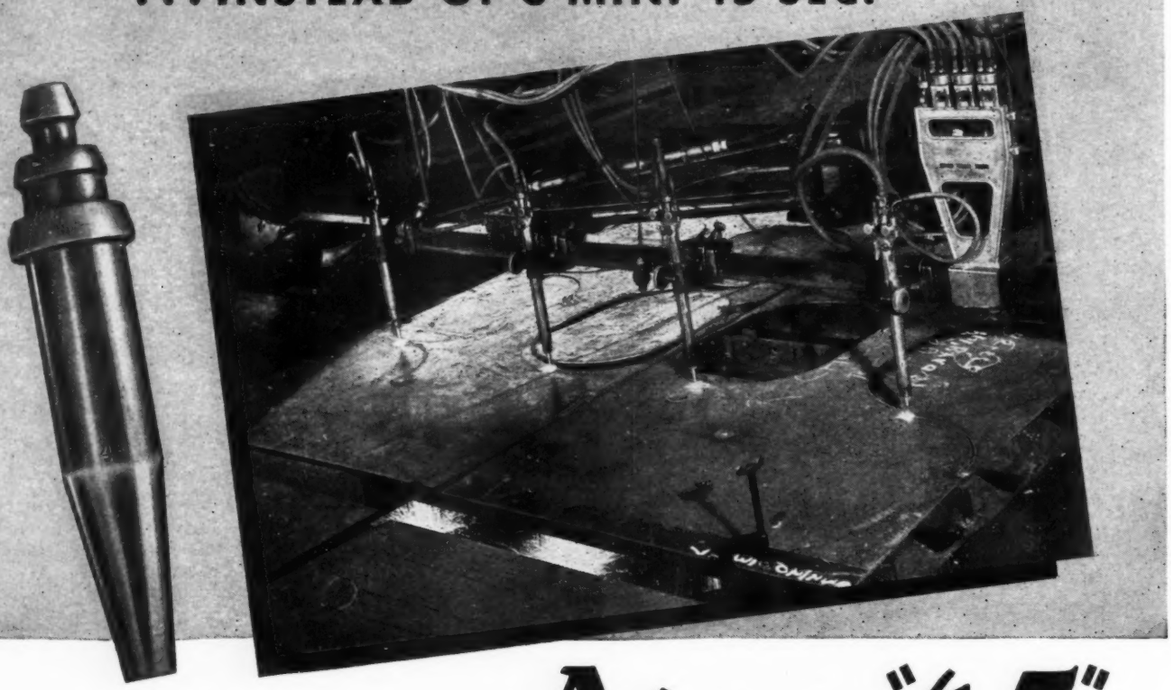
2. **Tangents**—keep weld away from zone of highest stress—simplify lining up.
3. **Precision quarter-marked end**—simplify layout and help insure accuracy.
4. **Selective reinforcement**—provides uniform strength.
5. **Wall Thickness never less than specification minimum**—assures full strength and long life.
6. **Machine tool beveled ends**—provides best welding surface and accurate bevel and land.
7. **The most complete line of Welding Fittings and Forged Steel Flanges in the World**—insures complete service and undivided responsibility.

SQUARES OF WHOLE NUMBERS

	0	1	2	3	4	5	6	7	8	9
1,000	1,000,000	1,002,001	1,004,004	1,006,009	1,008,016	1,010,025	1,012,036	1,014,049	1,016,064	1,018,081
1,010	1,020,100	1,022,121	1,024,144	1,026,169	1,028,196	1,030,225	1,032,256	1,034,289	1,036,324	1,038,361
1,020	1,040,400	1,042,441	1,044,484	1,046,529	1,048,576	1,050,625	1,052,676	1,054,729	1,056,784	1,058,841
1,030	1,060,900	1,062,961	1,065,024	1,067,089	1,069,156	1,071,225	1,073,296	1,075,369	1,077,444	1,079,521
1,040	1,081,600	1,083,681	1,085,764	1,087,849	1,089,936	1,092,025	1,094,116	1,096,209	1,098,304	1,100,401
1,050	1,102,500	1,104,601	1,106,704	1,108,809	1,110,916	1,113,025	1,115,136	1,117,249	1,119,364	1,121,481
1,060	1,123,600	1,125,721	1,127,844	1,129,969	1,132,096	1,134,225	1,136,356	1,138,489	1,140,624	1,142,761
1,070	1,144,900	1,147,041	1,149,184	1,151,329	1,153,476	1,155,625	1,157,776	1,159,929	1,162,084	1,164,241
1,080	1,166,400	1,168,561	1,170,724	1,172,889	1,175,056	1,177,225	1,179,396	1,181,569	1,183,744	1,185,921
1,090	1,188,100	1,190,281	1,192,464	1,194,649	1,196,836	1,199,025	1,201,216	1,203,409	1,205,604	1,207,801
1,100	1,210,000	1,212,201	1,214,404	1,216,609	1,218,816	1,221,025	1,223,236	1,225,449	1,227,664	1,229,881
1,110	1,232,100	1,234,321	1,236,544	1,238,769	1,240,996	1,243,225	1,245,456	1,247,689	1,249,924	1,252,161
1,120	1,254,400	1,256,641	1,258,884	1,261,129	1,263,376	1,265,625	1,267,876	1,270,129	1,272,384	1,274,641
1,130	1,276,900	1,279,161	1,281,424	1,283,689	1,285,956	1,288,225	1,290,496	1,292,769	1,295,044	1,297,321
1,140	1,299,600	1,301,881	1,304,164	1,306,449	1,308,736	1,311,025	1,313,316	1,315,609	1,317,904	1,320,201
1,150	1,322,500	1,324,801	1,327,104	1,329,409	1,331,716	1,334,025	1,336,336	1,338,649	1,340,964	1,343,281
1,160	1,345,600	1,347,921	1,350,244	1,352,569	1,354,896	1,357,225	1,359,556	1,361,889	1,364,224	1,366,561
1,170	1,368,900	1,371,241	1,373,584	1,375,929	1,378,276	1,380,625	1,382,976	1,385,329	1,387,684	1,390,041
1,180	1,392,400	1,394,761	1,397,124	1,399,489	1,401,856	1,404,225	1,406,596	1,408,969	1,411,344	1,413,721
1,190	1,416,100	1,418,481	1,420,864	1,423,249	1,425,636	1,428,025	1,430,416	1,432,809	1,435,204	1,437,601
1,200	1,440,000	1,442,201	1,444,804	1,447,209	1,449,616	1,452,025	1,454,436	1,468,849	1,459,264	1,461,681
1,210	1,464,100	1,466,521	1,468,944	1,471,369	1,473,796	1,476,225	1,478,656	1,481,089	1,483,524	1,485,961
1,220	1,488,400	1,490,841	1,493,284	1,495,729	1,498,176	1,500,625	1,503,076	1,505,529	1,507,984	1,510,441
1,230	1,512,900	1,515,361	1,517,824	1,520,289	1,522,756	1,525,225	1,527,696	1,530,169	1,532,644	1,535,121
1,240	1,537,600	1,540,081	1,542,564	1,545,049	1,547,536	1,550,025	1,552,516	1,555,009	1,557,504	1,560,001
1,250	1,562,500	1,565,001	1,567,504	1,570,009	1,572,516	1,575,025	1,577,536	1,580,049	1,582,564	1,585,081
1,260	1,587,600	1,590,121	1,592,644	1,595,169	1,597,696	1,600,225	1,602,756	1,605,289	1,607,824	1,610,361
1,270	1,612,900	1,615,441	1,617,984	1,620,529	1,623,076	1,625,625	1,628,176	1,630,729	1,633,284	1,635,841
1,280	1,638,400	1,640,961	1,643,524	1,646,089	1,648,656	1,651,225	1,653,796	1,656,369	1,658,944	1,661,521
1,290	1,664,100	1,666,681	1,669,264	1,671,849	1,674,436	1,677,025	1,679,616	1,682,209	1,684,804	1,687,401
1,300	1,690,000	1,692,601	1,695,204	1,697,809	1,700,416	1,703,025	1,705,636	1,708,249	1,710,864	1,713,481
1,310	1,716,100	1,718,721	1,721,344	1,723,969	1,726,596	1,729,225	1,731,856	1,734,489	1,737,124	1,739,761
1,320	1,742,400	1,745,041	1,747,684	1,750,329	1,752,976	1,755,625	1,758,276	1,760,929	1,763,584	1,766,241
1,330	1,768,900	1,771,561	1,774,224	1,776,889	1,779,556	1,782,225	1,784,896	1,787,569	1,790,244	1,792,921
1,340	1,795,600	1,798,281	1,800,964	1,803,649	1,806,336	1,809,025	1,811,716	1,814,409	1,817,104	1,819,801
1,350	1,822,500	1,825,201	1,827,904	1,830,609	1,833,316	1,836,025	1,838,736	1,841,449	1,844,164	1,846,881
1,360	1,849,600	1,852,321	1,855,044	1,857,769	1,860,496	1,863,225	1,865,956	1,868,689	1,871,424	1,874,161
1,370	1,876,900	1,879,641	1,882,384	1,885,129	1,887,876	1,890,625	1,893,376	1,896,129	1,898,884	1,901,641
1,380	1,904,400	1,907,161	1,909,924	1,912,689	1,915,456	1,918,225	1,920,996	1,923,769	1,926,554	1,929,321
1,390	1,932,100	1,934,881	1,937,664	1,940,449	1,943,236	1,946,025	1,948,816	1,951,609	1,954,404	1,957,201
1,400	1,960,000	1,962,801	1,965,604	1,968,409	1,971,216	1,974,025	1,976,836	1,979,649	1,982,464	1,985,281
1,410	1,988,100	1,990,921	1,993,744	1,996,569	1,999,396	2,002,225	2,005,056	2,007,889	2,010,724	2,013,561
1,420	2,016,400	2,019,241	2,022,084	2,024,929	2,027,776	2,030,625	2,033,476	2,036,329	2,039,184	2,042,041
1,430	2,044,900	2,047,761	2,050,624	2,053,489	2,056,356	2,059,225	2,062,096	2,064,969	2,067,844	2,070,721
1,440	2,073,600	2,076,481	2,079,364	2,082,249	2,085,136	2,088,025	2,090,916	2,093,809	2,096,704	2,099,601
1,450	2,102,500	2,105,401	2,108,304	2,111,209	2,114,116	2,117,025	2,119,936	2,122,849	2,125,764	2,128,681
1,460	2,131,600	2,134,521	2,137,444	2,140,369	2,143,296	2,146,225	2,149,156	2,152,089	2,155,024	2,157,961
1,470	2,160,900	2,163,841	2,166,784	2,169,729	2,172,676	2,175,625	2,178,576	2,181,529	2,184,484	2,187,441
1,480	2,190,400	2,193,361	2,196,324	2,199,289	2,202,256	2,205,225	2,208,196	2,211,169	2,214,144	2,217,121
1,490	2,220,100	2,223,081	2,226,064	2,229,049	2,232,036	2,235,025	2,238,016	2,241,009	2,244,004	2,247,001

Now 4 cuts in 2 min. 42 sec.

...INSTEAD OF 3 MIN. 45 SEC.



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HIGH SPEED MACHINE CUTTING TIP

At this plant, an Airco Travograph is flame cutting four identical shapes, 77″ in periphery, from 5/16″ steel plate in 2 min. 42 sec. — with the new Airco "45" High Speed Machine Cutting Tips.

1 min. 3 sec. — this is the saving in time now made possible by the Airco "45" in this multiple cutting operation, which until recently required 3 min. 45 sec. with conventional tips.

Airco "45" was developed to bring you maximum cutting speeds — at a time when speed became essential to the country's war efforts. It increases the speed of machine gas cutting by 20 to 30% — without sacrifice in the quality of the cut *and with no increase in oxygen consumption.*

If your plant is engaged in war production and utilizes Airco oxyacetylene machines for cutting steel up to 8″ thick, we urge you to ask your nearest Airco office for further details or to request our 8-page bulletin on Airco "45".

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WEIGHT OF DRY MATERIAL ADDED TO DRILLING MUD, LB. PER GAL. (SP. GR. OF ADDITIVE 3.00)

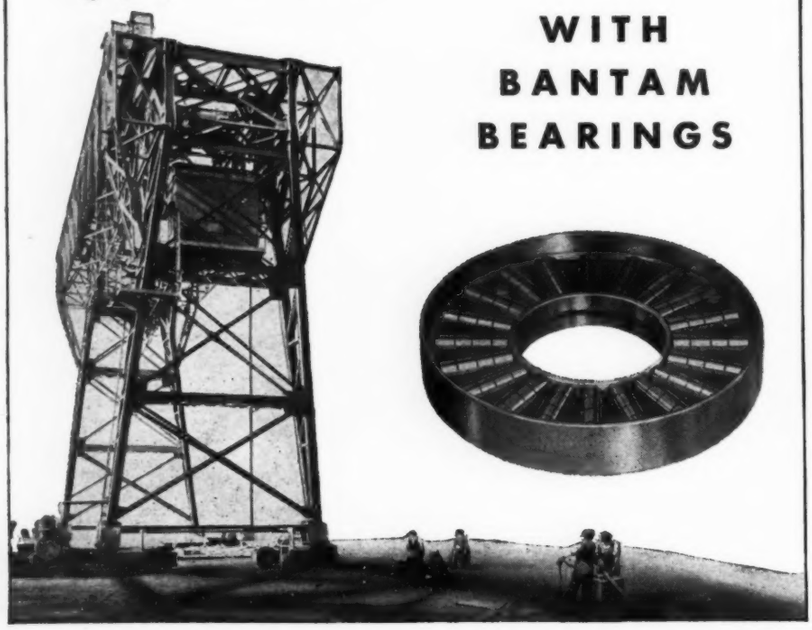
Original fluid, mud or water		Desired mud weight, lb. per gal.																				
Weight, lb. per gal.	Specific gravity	9.0	9.5	10.0	10.5	11.0	11.5	12.0	12.5	13.0	13.5	14.0	14.5	15.0	15.5	16.0	16.5	17.0	17.5	18.0	18.5	19.0	19.5
	1.08	1.14	1.20	1.26	1.32	1.38	1.44	1.50	1.56	1.62	1.68	1.74	1.80	1.86	1.92	1.98	2.04	2.10	2.16	2.22	2.28	2.34
*8.345	1.00	1.04	1.88	2.78	3.74	4.76	5.87	7.06	8.34	9.76	11.3	12.9	14.7	16.7	18.8	21.4	24.0	27.1	30.6	34.5	39.1	44.5	50.8
9.0	1.08		0.81	1.67	2.59	3.58	4.64	5.77	7.01	8.34	9.76	11.3	13.1	15.0	17.1	19.4	22.1	25.0	28.4	32.2	36.5	41.7	47.8
9.5	1.14			0.83	1.73	2.68	3.70	4.81	6.00	7.30	8.67	10.3	11.9	13.8	15.8	18.1	20.6	23.4	26.7	30.4	34.6	39.6	45.5
10.0	1.20				0.86	1.78	2.78	3.85	5.00	6.26	7.61	9.09	10.8	12.5	14.5	16.7	19.1	21.9	25.0	28.6	32.7	37.5	43.2
10.5	1.26					0.89	1.85	2.89	4.00	5.22	6.53	7.96	9.51	11.3	13.2	15.3	17.7	20.3	23.4	26.8	30.8	35.4	40.9
11.0	1.32						0.93	1.93	3.00	4.17	5.44	6.82	8.34	10.0	11.8	13.9	16.2	18.8	21.7	25.0	28.9	33.4	38.7
11.5	1.38							0.96	2.00	3.13	4.35	5.69	7.15	8.76	10.5	12.5	14.7	17.2	20.0	23.3	26.9	31.3	36.4
12.0	1.44								1.00	2.09	3.26	4.55	5.95	7.51	9.26	11.1	13.3	15.7	18.3	21.4	25.0	29.2	34.1
12.5	1.50									1.04	2.18	3.41	4.76	6.26	7.90	9.76	11.8	14.1	16.7	19.7	23.1	27.1	31.9
13.0	1.56										1.08	2.28	3.58	5.00	6.58	8.34	10.3	12.5	15.0	17.8	21.2	25.0	29.6
13.5	1.62											1.13	2.39	3.75	5.27	6.95	8.84	10.9	13.3	16.1	19.3	22.9	27.3
14.0	1.68												1.19	2.50	3.95	5.56	7.36	9.42	11.7	14.3	17.3	20.9	25.0
14.5	1.74													1.25	2.64	4.17	5.89	7.82	10.0	12.5	15.4	18.8	22.8
15.0	1.80														1.32	2.78	4.41	6.26	8.34	10.8	13.5	16.7	20.4
15.5	1.86															1.39	2.94	4.70	6.67	8.92	11.5	14.6	18.2
16.0	1.92																1.47	3.13	5.00	7.15	9.59	12.5	15.9
16.5	1.98																	1.57	3.34	5.36	7.70	10.4	13.7
17.0	2.04																		1.67	3.58	5.77	8.34	11.3
17.5	2.10																			1.78	3.85	6.26	9.09
18.0	2.16																				1.93	4.17	6.82
18.5	2.22																					2.09	4.55
19.0	2.28																						2.28

Note: The body of this table supplies the weight in lb. of the dry solid to be added per gal. to drilling fluid of known weight to obtain a mud of higher weight. The above table was calculated with an additive of specific gravity of 3.00.

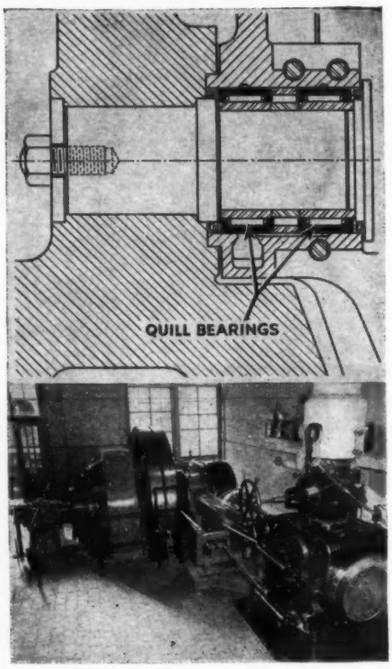
To use table find weight of original mud in left-hand column and desired mud weight in top line. Multiply figure from body of table by the volume of mud in gal. in well or mud pit to obtain the total amount in lb. of dry material to be added to obtain the desired mud weight.

*Water.

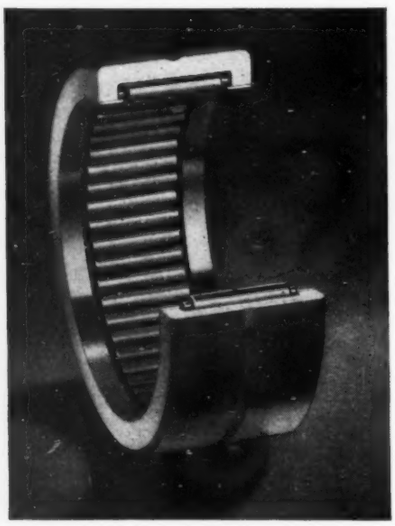
IN THE NEWS WITH BANTAM BEARINGS



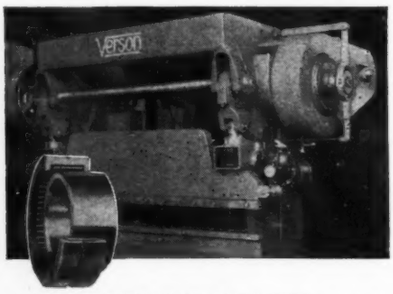
GIGANTIC SHIPBUILDING PROGRAM is a vital part of America's production for victory—and cranes in the nation's shipyards are called on to carry tremendous loads. This 350-ton gantry crane built by Shepard Niles Crane & Hoist Corporation—the largest of its type ever constructed—is used for handling battleship turrets. Bantam Roller Bearings under the collars of the load hook contribute to dependable operation of this giant crane. Bearings shown in inset are provided with Bantam's "Lubricage"—a special one-piece cage construction that facilitates correct lubrication.



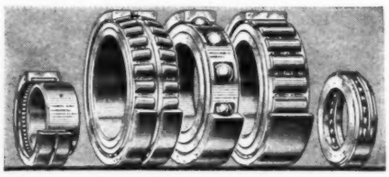
IN MODERN STEAM ENGINE DESIGN, efficiency and economy are prime considerations. In this Filer & Stowell 400 KW steam-electric generating unit, Bantam Quill Bearings on the governor arm contribute to efficient, economical operation, because of their low coefficient of friction and ability to run for long periods of time with little need of service attention. Location of Quill Bearings is shown in cross-section view.



READILY AVAILABLE FOR DEFENSE NEEDS, the Bantam Quill Bearing is constantly finding new industrial applications. Cut-away view shows the simple, rugged construction of this compact anti-friction bearing, widely used because of its low cost, high load capacity, small size, and ease of installation and lubrication. For full details on this unusual bearing, write for Bulletin P-104.



METAL FORMING PLANTS find many uses for this 45-ton press brake, built by Verson All-steel Press Company for such applications as straightening armor plate, forming aircraft parts, and producing munitions boxes and other equipment. High-speed flywheel shafts of these machines rotate on Bantam Quill Bearings.



BANTAM'S COMPREHENSIVE LINE includes bearings for practically every application in the oil industry. Angular Contact Bearings for rotaries, Straight Roller Thrust Bearings for swivels, Journal Roller Bearings for crown and traveling blocks, Quill Bearings for saddles and pitmans on pumpers—these are a few typical applications of Bantam Bearings. For advice on the selection of standard bearing types—or for special bearings designed to your requirements—TURN TO BANTAM.

BANTAM BEARINGS

STRAIGHT ROLLER • TAPERED ROLLER • NEEDLE • BALL

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Preference Order P-98 Amended and Extended to May 15

Principal provisions of Preference Order P-98 are retained until May 15 by virtue of an extension issued by the War Production Board, the Office of Petroleum Coordinator announced March 19.

No changes are made in the preference ratings, except that natural gasoline extraction plants are given the same ratings as refineries.

The principal difference between the old Order P-98, which expired Sunday, March 15, and the order as extended, is in the organization of subject matter. Formerly, the ratings were classified by functions: that is, production, refining, transportation, and marketing. Now, the grouping is by ratings: A-1s, A-2s, A-8s and A-10s.

The purpose of the rearrangement is to shorten and simplify the order. The definitions of production, refining, transportation, and marketing have been expanded, and a definition of "main gas trunk line" has been added.

A new inventory basis is also provided by the extension order. It defines minimum practicable inventory as one not exceeding 90 days' supply of materials.

One section of the extended order that is of considerable importance to many operators is that which defines maintenance, repair, and operating supplies. This section specifies that this type of supplies does not include material for the replacement of an item carried on the operator's books as a fixed asset. The operator, however, is permitted to apply the proper preference rating to materials for a part of such an item, if he can properly charge the cost to operating expense and not to capital account. Thus, if an operator wants to replace a joint in a pipe line, or a tubing or casing, and can properly charge the expense to operation and not to capital account, he can apply the preference rating that is assigned to maintenance, repair, and operating supplies.

The extended order makes clear that the A-1-E ratings, applicable to production materials used exclusively for prospecting (but not drilling), include specialized automotive equipment, used in such operations and attached to automobiles or trucks, but does not include automobiles, trucks, motors, parts of motors, tires, or chassis.

Aiding the natural gas industry is a provision that permits operators to apply A-2 ratings to chemicals used in extracting, cycling, and other plants. It avoids the delays experienced in applying for these materials on PD forms.

The order emphasizes that, if an operator who wants a material having a high rating can obtain it through a lower rating, he must use the latter. His supplier can inform him as to whether the material can be obtained under the lower rating.

Production Requirements Plan May Replace P-98

A fundamental change in the priorities system was announced March 22 by J. S. Knowlson, Director of Industry Operations. This means that P-98 will probably be rescinded at least with respect to the refining branch of the oil industry.

The WPB statement on the change follows:

"A specific requirements approach to the control and distribution of scarce materials will replace the use of general or blanket priority rating orders as rapidly as the necessary new orders and procedures can be put into effect. Between April 1 and June 30, most of the blanket rating orders will be revoked or allowed to expire, and companies which have been operating under blanket ratings will be required to apply for priority assistance under the Production Requirements Plan.

"The rapidly increasing materials requirements of the War program make it impractical to continue the use of preference ratings which have been assigned under existing 'P' orders to whole industries, without any exact check of the amount of material which such ratings may be used to obtain. Through the Production Requirements Plan, the Director of Industry Operations will continue to assign ratings to deliveries of materials for essential uses, but the rating assigned in each case may be used to obtain only a specified quantity of materials or products.

"Under the Production Requirements Plan, a company makes a single application for priority assistance covering all its estimated materials needs over a three-month period. The applicant must submit full information as to his inventories, the end use of his products, etc. Priority ratings are assigned on the basis of such applications to permit producers of products essential to the war effort or minimum civilian needs to obtain specified quantities of materials during a quarter. Interim applications may be filed when a company needs additional quantities of material during the quarter because of increased war or other essential business.

"A Modified Production Requirements Plan has been developed to meet the needs of small firms whose business is less than $100,000 a year. Such companies may use a simplied application form, PD-25X.

"The effect of placing virtually all American industry, including producers who supply the Army and Navy, under the Production Requirements Plan will be to give the War Production Board close control of the distribution and use of all scarce materials. The most important raw materials, such as aluminum, copper, steel plates, etc., are already allocated at the producer's level. General use of the Production Requirements Plan will provide control of the flow of these materials down to the level of end products.

"Because it would be physically impossible to handle the load of PRP applications if they were to be submitted immediately from all companies in all industries, the changeover from the use of blanket ratings will be continuous over a period of three months, and each industry will be notified as to the date by which the change must be completed. A considerable number of 'P' orders have already been amended to provide that after a specified date, the blanket ratings assigned by such orders will be revoked, and producers who have been using them will have to apply for priority assistance under PRP.

"Processing of PRP applications will be handled in co-operation with the appropriate industry and materials branches of the War Production Board in such a way that all companies producing similar products for similar uses will receive uniform treatment.

"New limitation or conservation orders will continue to be issued to curtail production by non-essential and less essential industries which still use scarce materials, and to force substitutions for scarce materials wherever possible in essential industries. All ratings assigned under PRP will be subject to such controls.

"Use of the new procedure, in combination with limitation orders and the materials orders already in effect, will permit administration of the Production Requirements Plan to expedite direction of American resources into the most effective channels for promotion of the war effort.

"PRP is not a new and untried program. The plan was announced early in December, and a considerable number of companies have been operating under it since January 1. PRP itself grew out of the old Defense Supplies Rating Plan, which was first announced nearly a year ago.

"The extension of PRP to cover a much broader field, and its substitution for 'P' orders, will constitute another long step toward gearing the whole American economy into the war program. When the changeover is completed, priority assistance will be granted only for specified quantities of materials or products, and the War Production Board will then be in a position to go as far toward complete allocation as war needs may require.

"The statistical information obtained as more and more companies operate under PRP will enable the Division of Industry Operations, in co-operation with the WPB Requirements Committee, steadily to improve the assignment of ratings and allocations of materials for various industries. In the meantime, a mechanism for controlling the distribution and use of all scarce materials will have been set up.

"The industry branches in the Bureau of Industry Branches and the priorities staff of the Bureau of Priorities have been ordered by the Director of Industry Operations to put the new policy into effect as rapidly as possible. Specific announcements will be made in each case as additional industries are affected by the program."

Conservation Order M-68—Procedure for Filing Exceptions

New procedure for filing applications for exceptions under Conservation Order M-68 was explained March 24, by the Office of Petroleum Coordinator.

Under this procedure, it was stated by Deputy Coordinator Ralph K. Davies, three copies of the application should be sent directly to the Director of Production, Office of Petroleum Coordinator, New Interior Building, Washington, D. C.

A fourth copy of the application should be mailed or delivered to the OPC District Office for the district in which the lease, pool, or plant is located.

Davies explained that the change was made to expedite the handling of requests for exceptions. Formerly, operators were required to send all four copies of the application to the Washington office. As a result, time was lost while the Washington office, in turn, forwarded one copy to the district office.

"We want the industry to take advantage of all the short-cuts possible under the new system of filing applications for exceptions," Davies said.

"Object of sending three copies to Washington and one to the district office directly is to speed up OPC's aid to industry. The new system will permit field and Washington offices to analyze the same request simultaneously. When the district office's comment is received in Washington, the application can then receive prompt consideration."

This procedure applies to all three application forms for exceptions under M-68. Form 214-a is used by operators applying for an exception for an entire pool or drilling program; form 214-b for an exception for an individual lease, property or well; and form 214-c for an exception for a cycling plant or a repressuring plant.

District offices and the States they cover are:

District 1—1104 Chanin Building, 122 East 42nd Street, New York City, for Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Delaware, Maryland, Virginia, West Virginia, North Carolina, South Carolina, Florida, and the District of Columbia.

District 2—Suite 1336, 120 South La Salle Street, Chicago, Illinois; for Michigan, Ohio, Kentucky, Tennessee, Indiana, Wisconsin, Minnesota, Iowa, Missouri, North Dakota, South Dakota, Nebraska, Kansas, and Oklahoma.

District 3—245 Mellie Esperson Building, Houston, Texas, for Alabama, Mississippi, Louisiana, Arkansas, Texas, and New Mexico.

District 4—421 U. S. National Bank Building, Denver, Colorado, for Montana, Wyoming, Colorado, Utah, and Idaho.

District 5—855 Subway Terminal Building, Los Angeles, California, for Arizona, California, Nevada, Oregon, Washington, and Territories of Alaska and Hawaii.

Recommendation No. 40—Reduction in Additives for Motor Oil

Since April 6 the use of additives in the manufacture of lubricating oils and greases has been restricted as follows:

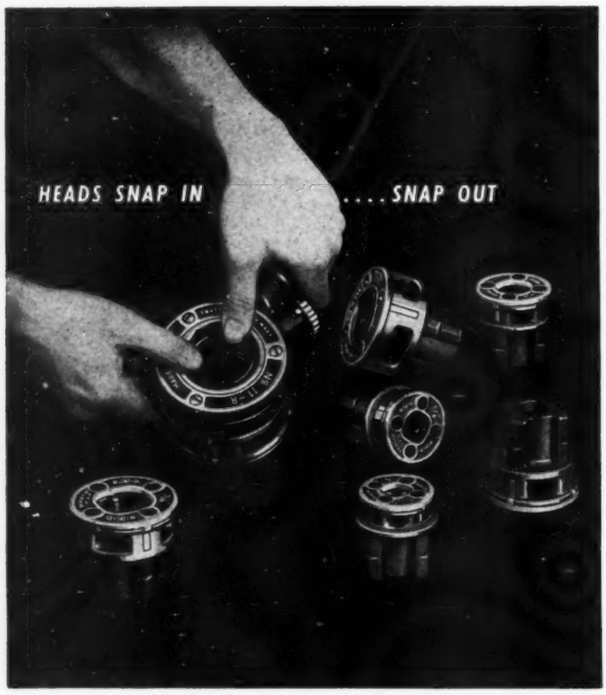
Cresol: lubricants containing additives requiring cresol must be designated not for passenger car use.

Detergent or detergent dispenser type additives: lubricants containing must be marked not for passenger car use.

Oxidation inhibitors: use of these additives to be reduced as much as possible.

Pour point depressants: use to be reduced by (a) maximum utilization of dewaxing facilities, (b) pour points revised upward to meet temperature requirements of each locality.

Extreme pressure lubricants: these lubricants to be marked not for passenger car use and a straight mineral oil lubricant substituted. Chlorine is eliminated in the manufacture of chassis lubricants. All-purpose type lubricants are to be eliminated where possible.



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If this Housing ever Breaks or Distorts we will replace it Free
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All manufacturers of lubricating oils and greases are required to report within 45 days, the saving of additives under the recommendation.

The announcement of OPC on the recommendation follows:

"Immediate reduction in the quantity of scarce chemicals used as additives in automotive lubricating oils and greases was called for today (March 19) in a formal recommendation (No. 40) issued to oil refiners and distributors by the Office of Petroleum Coordinator.

"The recommendation is primarily a measure to conserve chemicals necessary for the production of the high-grade lubricants essential for the armed forces and war industries. It follows a War Production Board announcement that the supply of chemicals used in additives has declined seriously.

"Additives are substances that, combined with natural lubricating oil, provide desired characteristics of the lubricants. Among the qualities attributed to certain additives in lubricating oils and greases are fluidity at low temperatures, maintaining viscosity at high operating temperatures, decreased friction, protection of cylinders and bearings against corrosion, and decreased engine deposits that may cause ring sticking.

"Oil refiners are requested, under the recommendation, to reduce or eliminate completely the use of certain additives in lubricants for passenger cars, light delivery trucks, taxicabs, limousines, and business cars.

"No changes are recommended, however, for lubricants used in heavy-duty equipment, police cars and motorcycles, ambulances, busses, or cars in official use by the armed forces. Lubricants for these cars will be marked 'not for use in passenger cars,' and marketers will be expected to comply with the sales instructions on each container.

"All manufacturers of lubricating oils and greases have been requested to report on the results of this conservation measure within 45 days.

"The Office of Petroleum Coordinator said that the elimination or reduction of additives from lubricating oils and greases will not greatly affect the efficiency of private cars.

"Oil and greases will maintain their efficiency, even though the amount of additives used will be reduced. OPC pointed out that most commercial lubricants have a very high safety factor. Reduction in additives only reduces the range from a very high to a high point, thus providing the machinery with a safe lubricant and, at the same time, conserving precious chemicals.

"Eliminated completely for use in additives to lubricants for passenger and other light cars are cresol, metallic detergents, and chlorine for chassis lubricants. No extreme-pressure lubricants may be used in the transmissions of passenger and other light cars. Reduced use of additives is recommended for oxidation-inhibitors and pour-point depressants. Elimination, where possible, of extreme-pressure lubricants in transmissions of all heavy-duty equipment was also asked as a conservation measure."

Panhandle Crude Oil Increase Denied

The Office of Price Administration denied March 23, 1942, a request of several Texas producers to equalize maximum prices for Texas Panhandle crude oil with those established for Oklahoma and Kansas crudes, according to an announcement by John E. Hamm, Acting Administrator.

Request for removal of a 10 cents per bbl. differential in favor of the Oklahoma and Kansas crude oils came from the Panhandle Producers and Royalty Owners' Association of Amarillo, Texas, and J. P. Coleman of Wichita Falls, Texas. Their request was made on November 24, 1941, and was followed by an investigation by the OPA Fuel Division.

In denying the request for an equalization of prices for the two fields, Hamm said, in part:

"There is strong economic justification for the existence of a price differential between the two areas because of the less favorable geographic position of the Panhandle and because Panhandle crude oil has certain undesirable qualities that lead to higher refining costs.

"While it would be extremely difficult to determine whether the proper differential is the existing differential or one of a cent higher or lower, it is true that the present differential of 10 cents is the lowest that has obtained in a long period. Panhandle crude prices have increased more than those in any of the surrounding areas in recent years. Any further increase at a time when inflation threatens our effective prosecution of the war seems unjustified on the basis of the information submitted."

The notification of refusal also points out that this action by the OPA in no way affects the rights of the producers to file protests or petitions under the Emergency Price Control Act of 1942.

Pennsylvania Grade Crude Oil Prices Increased

OPA on March 24 announced an amendment to its price order on Pennsylvania grade crude oil permitting an increase in its price of 25 cents at this time and promising an additional 25-cent increase when the daily production over a three-months' period averages 85,000 bbl. a day.

The OPA press release follows:

Military demands for a substantial and rapid increase in production of Pennsylvania grade crude oils has caused the issuance by the Office of Price Administration of Amendment No. 3 to Revised Price Schedule No. 88, permitting an increase of 25 cents per bbl. for all grades, effective March 25, 1942. A second advance of like amount also has been assured when production reaches 85,000 bbl. per day average over a three-months' period.

Announcement of the price revision was made by John E. Hamm, Acting Price Administrator.

The price revision followed exhaustive investigations by OPA and the Office of Petroleum Coordinator. To reach the production goal required to supply expected war and other demands it is estimated that an expenditure by the industry of approximately $15,000,000 annually will be necessary for three years in repressuring, reconditioning, and drilling of new wells.

New maximum prices, as set by the amendment, with the maximums set under Revised Price Schedule No. 88, follow:

Grades of crude oil	*Previous maximum per bbl.*	*New maximum per bbl.*
Pennsylvania Bradford	$2.75	$3.00
Southwest Pennsylvania	2.40	2.65
Eureka	2.34	2.59
Southeastern Ohio	2.30	2.55
Oil City-Titusville:		
Group A	2.68	2.93
Group B	2.67	2.92
Group C	2.66	2.91
Group D	2.65	2.90
Group E	2.63	2.88

Group A includes Cochran, Franklin, Hamilton, and Doolittle districts; Group B covers the Titusville district; Group C includes Turkey and Tidiout; Group D includes Bear Creek and Porkey districts; and Group E includes Eideneau, Bowl Creek, Rough Run, Carbon, Ditner, Bredin, McJunkin, Jameson, Kennerdall, Emlenton, Tiona, Lacy, and Kinzua districts.

At the time the original price schedule was established, production of Pennsylvania grade crude oil approximated 75,000 bbl. a day, or about 2 percent of the total daily output of crude oil in the United States. Later average monthly production increased slightly whereas crude runs to refineries reached a figure above 80,000 bbl. a day by means of withdrawals from stocks. These stocks now are approaching a working minimum.

The description "Pennsylvania crude" refers to the oils possessing special qualities characteristic of oils produced in Pennsylvania. Most of the output comes from wells in Pennsylvania, but substantial quantities also are recovered from wells in New York State, Southeastern Ohio, and northern West Virginia.

"Bradford Crude" is Pennsylvania grade oil produced from the Bradford and Allegheny pools; "Southwest Pennsylvania" is oil from wells in that area; "Southeastern Ohio" is from the area its name indicates. "Eureka Crude" is produced by wells in West Virginia run by the Eureka Pipe Line. "Oil City-Titusville" oils are from wells in that generally-defined area in Pennsylvania.

An order that accompanies Amendment No. 3 revokes Maximum Price Schedule No. 22, which set the original maximum prices for Pennsylvania grade crude oil. This schedule is revoked because provisions for maximum prices for Pennsylvania crude by Amendment No. 3 become a part of Revised Price Schedule No. 88 for Petroleum and Petroleum Products.

Chlorine Restricted

Drastic restrictions on the use of chlorine, which were ordered by WPB in amendment No. 1 to Order M-19, have been postponed to May 1.

Producers of chlorine are instructed to make deliveries only on specific authorization of the Director of Industry Operations, with the exception of chlorine for water and sewage treatment.

They are required to set aside from each month's production 5 percent for delivery on specific instructions and enough additional to take care of their regular water and sewage treatment demands.

Chlorine for use in petroleum production is assigned a rating of A-10; petroleum product additives, B-2.

Suggestions for War-Time Plant Design

American oil refiners and refining-plant contractors are responding enthusiastically to suggestions, recently issued by the Office of Petroleum Coordinator, to conserve critical materials and machines used in refineries, Petroleum Coordinator Harold L. Ickes said March 31.

OPC'S Refining Division already has received additional suggestions from many members of the industry throughout the country, the Coordinator added.

Issued as a mimeographed leaflet, "Suggestions for Wartime Plant Design," the conservation memorandum points out what materials or equipment are scarce and what substitutes can be used, at least for the duration, to perform similar functions. Discussing the conservation program, Deputy Coordinator Ralph K. Davies stated:

"Every refiner at one time or another has thought about one or more of these substitutes for critical materials used in American refineries. Our suggestions are helpful to the industry because we have crystallized ideas from all sections of the country and have made these available in one pamphlet."

Materials that will be conserved in future construction and repair work on refineries include sheared steel plate, used for making refinery apparatus; galvanized steel sheets, used to weatherproof insulation; non-ferrous metals; steel tubes, and power equipment.

OPA Agreements Not Violative of Anti-Trust

Any danger that agreements made by industry members with the Office of Price Administration pursuant to the Emergency Price Control Act of 1942 would violate anti-trust laws is removed by the terms of the Act, Price Administrator Leon Henderson stated in response to queries raised recently.

"Such agreements are now authorized by act of Congress," Henderson said. "The Emergency Price Control Act of 1942, in Section 5, specifically provides that '. . . the Administrator is authorized . . . to enter into voluntary arrangements or agreements with any . . . persons, groups, or associations relating to the fixing of maximum prices, the issuance of other regulations or orders, or the other purposes of this act . . .'

"The Office of Price Administration may thus proceed, under its own power, to complete agreements which will prevent undue price increases. Formerly we had acted in accordance with letters from the Attorney General granting permission to make such agreements. Under the new statutory procedure the Attorney General is furnished with a copy of the agreement after it has been entered into. While we shall continue to work in close collaboration with the Department of Justice, the protection afforded to our voluntary agreements with industry is now statutory."

Henderson further emphasized that the Office of Price Administration will continue to rely upon such voluntary agreements as the wholehearted co-operation of industry has been and will be an important aid toward the type of price control essential to our war effort.

Amend Price Schedule for Petroleum

Means for establishing uniform maximum prices for crude petroleum in pools where new wells have been opened or old wells reopened subsequent to October 1, 1941, are provided in Amendment No. 5 to Revised Price Schedule No. 88 for Petroleum and Petroleum Products, announced by John E. Hamm, Acting Price Administrator.

The amendment became effective April 9, 1942.

The Price Schedule previously provided that where there was no purchase price posted as of October 1, 1941, for the pool in which a well completed or reopened after October 1, 1941, is located, a purchaser might set a temporary price for crude petroleum produced from the new or reopened well, provided the price and a description of the crude petroleum were reported to OPA within ten days.

The amendment provides that such temporary price now shall be subject to disapproval by OPA. If the temporary price is a posted price, it shall, unless disapproved by OPA, be the maximum price at the well for crude petroleum produced from any wells located in the pool in which such new or reopened well is situated. The provision also covers wells representing discovery and development of new pools subsequent to October 1, 1941.

——— ☆☆☆ ———

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And then when you can pit that pump against higher-priced, heavier, many-parted pumps *and get better results all around,* you have a pump that's *years ahead* of the field.

Fluid Packed is manufacturing just such pumps—the new Flupaco "Groove Seals"—following more than two years of shirt-sleeve engineering and development work in the field of pump design—of metallurgy—of manufacturing—and of testing. Right now, these lighter, streamlined pumps with their one-piece hardened and honed barrels and many other far-reaching advancements are, in many cases, replacing pumps weighing *four times as much* . . . with no letdown in efficiency and with material savings in power costs, in production costs and in pump maintenance. EVERYWHERE these new Flupaco Pumps are turning in performance records previously believed impossible to achieve with pumps so economically priced!

Every operator—large or small—who wants to cut the cost per barrel lifted can find a ready solution in these new Flupaco "Groove Seals." There's no obligation whatever in contacting your nearest Fluid Packed representative for complete information and help on your pump problems . . . or write direct for the new descriptive catalog!

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Running Tour

WITH MEN IN THE INDUSTRY

JOHN B. SCHUYLER, materials specialist, has opened a materials division in the District 4 office at Denver, Colorado, to aid Rocky Mountain oil operators in obtaining priority ratings, according to an announcement from the Office of Petroleum Coördinator. Schuyler joined the staff of the coördinator in January, 1942.

B. W. CLARK, vice-president in charge of the Westinghouse Electric and Manufacturing Company's merchandising division, has been appointed vice-president in charge of sales of the company. He succeeds RALPH KELLY, who has resigned to become executive

B. W. CLARK

vice-president of the Baldwin Locomotive Works. GEORGE H. BUCHER, president of Westinghouse, announced that Clark, in addition to supervising the sale of apparatus, will be responsible for coördinating all sales of Westinghouse and its subsidiaries. He will transfer his headquarters from Mansfield, Ohio, to Pittsburgh, Pennsylvania.

G. A. BASSETT, president, St. Paul Hydraulic Hoist Company, Minneapolis, Minnesota, announces that W. S. SCRUGGS has been elected a vice-president. Scruggs, who has been connected with the motor truck and hoist industries for the last 25 years, will continue his duties as general manager.

OSBORNE BEZANSON, general manager of the Texas Division of Monsanto Chemical Company, was elected a vice-president of the company at the regular monthly meeting of the board of directors. All other officers were reëlected.

JOSEPH B. EASTMAN, Director of Defense Transportation, has announced the appointment of A. V. BOURQUE as consultant to FAYETTE B. DOW, assistant to Eastman on pipe lines, tankers, tank cars, and tank trucks. Bourque, who is executive secretary of the tank car service committee, Chicago, Illinois, will serve without compensation. Eastman also announced the appointment as consultant, of SAMUEL ELDER, Boston, Massachusetts, and Washington, D. C., lawyer, who assisted in the collection of data for the industry report on petroleum transportation to the Temporary National Economic Committee.

L. A. MEKLER, combustion engineer, Universal Oil Products Company, Chicago, Illinois, presented a paper entitled, "Metallurgical Problems in Oil Refining Processes in National Defense," before the Western Society of Engineers, April 6. Mekler, who is widely experienced in the design of industrial heaters, particularly for use in oil refineries, stated that new processes for producing from petroleum the constituents of 100-octane fighting gasoline, synthetic rubber, and other war products, require special alloy steels to withstand the temperatures and pressures employed, and to be "inert" to the catalysts and the materials processed.

CLAUDE P. PARSONS, vice-president of the Halliburton Oil Well Cementing Company, Duncan, Oklahoma, addressed the student section of the American Institute of Mining and Metallurgical Engineers of the University of Texas recently on "Caliper Logging."

ROBINSON S. KERSH, industrial sales engineer, has been appointed manager of the Houston, Texas, office of the Westinghouse Electric and Manufacturing Company, according to C. E. ALLEN, southwestern district manager.

DR. C. D. LOWRY, JR., of the Universal Oil Products Company, Chicago, Illinois, delivered a paper recently on "Petroleum's War Assignments in Aviation Gasoline and Rubber" before three joint meetings of the department of manufacture and the department of standards and tests of the National Petroleum Association.

JOSEPH T. WRIGHT has been appointed manager of the compressor and tool division at its Holyoke, Massachusetts, Works, according to an announcement by Worthington Pump and Machinery Corporation.

C. J. WILHELM, engineer, U. S. Bureau of Mines, Bartlesville, Oklahoma, will be located in Franklin, Pennsylvania, as director of a new experimental station.

LEVI ACKLEY, Tulsa, Oklahoma, producer, is head of the Oklahoma State campaign for scrap metal and is directing the activities of the committee headed by E. H. MOORE.

HOWARD COONLEY is now chief of the simplification branch of the Bureau of Industrial Conservation, War Production Board. He succeeds DR. EDWIN W. ELY, recently returned to duties as chief of the division of simplified practice of the National Bureau of Standards. Coonley is chairman of the board of the Walworth Company.

A. L. VITTER, JR., senior petroleum engineer in the Minerals Division of the Louisiana Department of Conservation, has been granted a leave of absence to teach electronics at Harvard University.

P. L. BROOKS, formerly Pacific Coast manager for the Parkersburg Rig and Reel Company, has been transferred from the Los Angeles, California, office to company headquarters at Parkersburg, West Virginia, and promoted to manager of industrial sales. C. F. STROVER, of the Los Angeles office, has been named acting Pacific Coast manager.

P. L. BROOKS

JOHN W. BRICE has been elected vice-president of The Carter Oil Company. Brice will be in charge of exploration, research, and the manufacture of specialized equipment. F. H. MOSES, chief geologist and manager of exploration, has been elected a director of the company.

JOHN GAYNOR, of the Shell Oil Company of Ecuador, presented movies of his trip to and from that concession and gave a most interesting talk on the general outlook for oil production in that country at the regular monthly meeting of the Houston, Texas, Chapter of Nomads, April 7.

L. S. REED has been elected vice-president of the Texas Gulf Producing Company, Houston, Texas, succeeding F. W. DUMRAESE, recently killed in an automobile accident. G. W. REED has been reëlected president; W. H. HENDRICKSON, reëlected secretary-treasurer, and T. S. TALIAFERRO, assistant secretary.

J. A. TRAUGHBER, superintendent for the Transwestern Oil Company, is now at Oklahoma City, Oklahoma, having been transferred from Hutchinson, Kansas.

R. W. McCLENAHAN, manager of the Philadelphia, Pennsylvania, factory of American Meter Company, has been

R. W. McCLENAHAN

granted leave of absence as of March 27 to join the United States Army as a Major. McClenahan was appointed manager of the factory in 1936.

M. E. BROCK, Gulf Oil Corporation, Houston, Texas, has been appointed chairman of the Advisory Committee on Disposal of Production Wastes of the American Petroleum Institute's Division of Production. The committee's function will be that of an advisory and consulting nature and replaces the former Committee on Disposal of Production Wastes. C. A. YOUNG is secretary. GEORGE A. HILL, JR., chairman of the division's general committee, appointed T. L. FONTAINE, Humble Oil and Refining Company, Houston; KURT H. DE COUSSER, Socony-Vacuum Oil Company, Inc., Lansing, Michigan; D. B. DOW, Indian Territory Illuminating Oil Company, Bartlesville, Oklahoma; R. B. KELLY, The Pure Oil Company, Olney, Illinois; A. S. RITCHIE, McPherson Drilling Company, Wichita, Kansas, and J. SAMUELSON, General Petroleum Corporation of California, Los Angeles.

W. A. MIDDLETON, JR., former district engineer for the Texas Railroad Commission in district 8 at Midland, Texas, is now on active duty as a second lieutenant in the U. S. Army at Camp Roberts, California.

W. T. RADFORD, assistant district superintendent for the Humble Oil and Refining Company, production department, has been transferred from the Sand Hills district to the Hurdle district, West Texas. Other changes announced by the company are as follows: W. T. ILFREY, office petroleum engineer, has been appointed district petroleum engineer at North Crowley; J. VERNON BLACKLOCK, assistant chief clerk in the Galveston Bay district, was transferred to Chalkley as chief clerk; JESSE E. LAWRENCE, transportation foreman in Galveston Bay district, was appointed division transportation foreman in the Louisiana division; GEORGE M. CHAFFEE, farm boss, was transferred from the Galveston Bay district to the Chalkley as district superintendent in charge of operations; J. I. COCHRAN, district superintendent, was transferred from the Chalkley district to Paradis, Louisiana; R. A. WILLIAMS, chief clerk, has been transferred from Chalkley to Paradis; E. C. McCANLIES, district chief clerk, was transferred from the Heyser gasoline plant to the Katy gas cycling plant.

P. H. PATCHIN, San Francisco, California, formerly director of public relations, later a director, of the Standard Oil Company, has been elected a vice-president. Patchin will assume new duties in Washington, D. C., according to an announcement by the company.

ALFRED KENT, formerly Dallas, Texas, representative for Manning, Maxwell and Moore, Inc., Bridgeport, Connecticut, has enlisted in the U. S. Navy as an ensign and is now on active duty at the Charleston, South Carolina, Navy Yard. FRED CRABBE, who formerly covered the Corpus Christi, Texas, territory, has been transferred to Dallas to cover the territory formerly covered by Ensign Kent for the duration.

W. N. FINNEGAN, JR., has rejoined Humble Oil and Refining Company, effective March 31, the company announced. He will be in the geologic, land and scouting department, which is headed by Vice-President L. T. BARROW. Finnegan also will be in charge of public relations, the position he held formerly.

ODELL OLSON, Brady, Texas, has joined the staff of the Texas Railroad Commission as geologist.

HERBERT SPENCER, formerly assistant manager of asphalt sales of the Standard Oil Company, New Jersey, has been reëlected president of the Asphalt Institute. W. R. MACATEE was reëlected managing director; DAVID WAXMAN, Shell Oil Company, Inc., was elected chairman of the executive committee; J. A. BLOOD, Standard Oil Company of California, D. H. DRESSER, Anderson-Pritchard Oil Corporation, and H. B. PULLAR, Berry Asphalt Company, were elected vice-presidents. GEORGE R. CHRISTIE, Socony-Vacuum Oil Company, Inc., was elected secretary-treasurer, and J. N. SMITH, Socony-Vacuum Oil Company, Inc., assistant treasurer.

J. J. ARPS, district engineer for The British-American Oil Producing Company, has been appointed production

J. J. ARPS

superintendent for the company's Gulf Coast District with headquarters in Houston, Texas.

H. C. WIESS, president of the Humble Oil and Refining Company, Houston, Texas, and W. M. GRIFFITH, vice-president of Plymouth Oil Company, Sinton, Texas, were guests of honor at the fifth annual meeting of South Texas oilmen in San Antonio, Texas, April 17.

D. M. LOGAN, formerly of the petroleum machinery section of the War Production Board in Washington, D. C., has been transferred to the Office of Petroleum Coördinator and assigned to field work. He will make his headquarters in Oklahoma City, Oklahoma.

C. H. KEPLINGER, production engineer, Shell Oil Company, Inc., has been transferred from Tulsa, Oklahoma, to the division office in Centralia, Illinois.

H. H. COLLETON has received a promotion from chief gauger to district foreman for the Stanolind Pipe Line Company at Wink, Texas.

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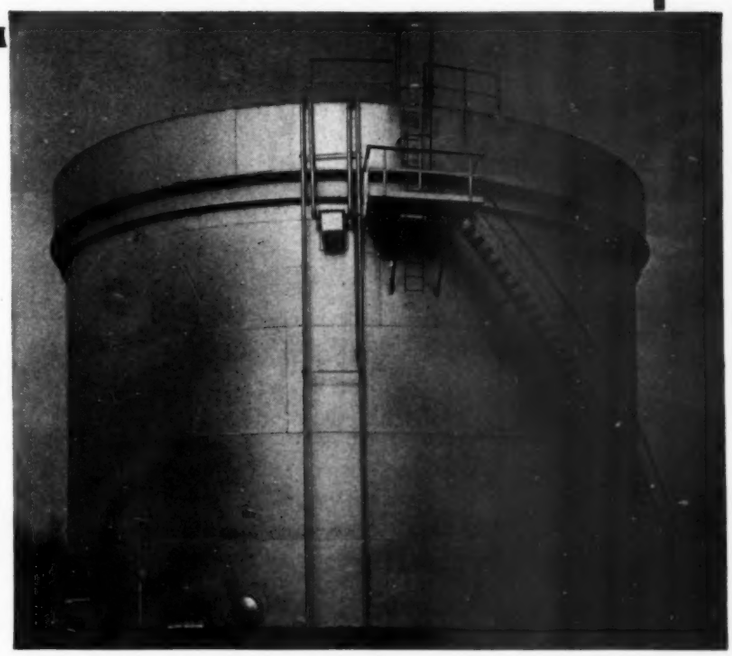

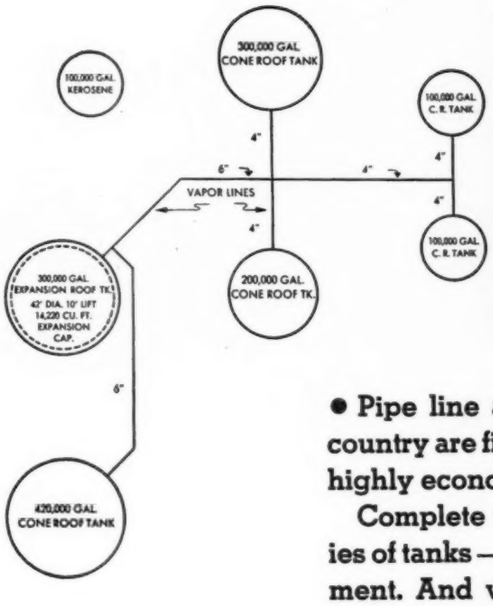

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Complete vapor protection — not for just one tank — but for batteries of tanks — is being obtained through the use of this modern equipment. And with one roof protecting several tanks, it means considerable savings in product, equipment, and maintenance.

The sketch at the left shows hook-up of an actual installation. One glance at it will tell you why a Graver Expansion Roof will save money for you by protecting a battery of your tanks from breathing and evaporation losses.

One roof protecting six tanks and no evaporation loss from either — that's why the Graver Expansion Roof is an investment—not an expense. The sooner you find out about it, the sooner you will have the practical solution to the problem of preventing evaporation during gasoline storage periods. Write for details today!

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Before the time comes to land and cement casing, it is highly important to know that the guiding, floating and cementing equipment you intend to use will perform these three vital operations . . .

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Only one shoe can be BEST

Mere words will not prove any product to be the BEST of its kind, but when thousands of cementing jobs have been successfully completed, many under conditions where other shoes have failed, the results clearly brand as BEST the Baker Cement Wash-Down Whirler Float Shoe.

This shoe is the logical outcome of many years experience in designing equipment for guiding, floating and cementing casing—proving such equipment satisfactory for the needs of that period—and constantly improving it to meet changing conditions and to provide greater efficiency.

Here are FACTS you should know

THREADED CONNECTION FURNISHED TO FIT ANY TYPE CASING. Baker Floating Units can be furnished with threaded connection to fit the specifications of your casing. (Float collars can be furnished with both "female" and "male and female" threaded connections.) Manufacturing precision assures thread uniformity and accuracy.

AMPLE STRENGTH. The seamless steel casing shoe into which the concrete plug and Plastic BALL-TYPE Valve Assembly are securely anchored provides a unit that has STRENGTH to float the longest and heaviest string of casing with an ample factor of SAFETY.

POSITIVE, LEAK-PROOF BACK-PRESSURE VALVE. The buoyant Plastic BALL-TYPE Back-Pressure Valve floats in the cement slurry or rotary mud and instantly forms a leak-proof double seal against a narrow, tough rubber ring (backed by Plastic and concrete) at the slightest reversal of pressure. Here is Valve Efficiency at its best.

AMPLE CIRCULATION AREAS. The correctly designed, streamlined Valve Assembly provides passageways ample for any circulating or cementing operation . . . a fact attested to by actual field performance under the most severe operating conditions.

BAFFLED WHIRLER PORTS. These whirler ports provide the important wash-down whirler action so advantageous in circulating and cementing operations. When the fluid strikes these baffled ports, a downward and then an upward whirling motion results. In running in, this whirling action provides a means of effectively washing away bridges. During cementing, the whirling action, imparted first to the fluid preceding the slurry and then to the slurry itself, properly prepares the hole to receive the cement. It then assures best possible distribution of a uniform body of cement around the shoe and the shoe joint, reducing the hazard of channeling to a minimum. Here is the ultimate in cementing efficiency.

EASY DRILLABILITY. Complete and easy drillability results from the internal construction of Baker-Formula Concrete and Plastic . . . the Plastic BALL-TYPE Valve Assembly being set on end in the concrete plug to present a minimum cross-sectional area to the drilling bit. The concrete and the Plastic are quickly and easily drilled up and circulated out of the hole. For complete details concerning Baker Cement Whirler Equipment, contact the nearest Baker office or field representative; or refer to Pages 227 to 229 of the 1942 Baker (or Composite) Catalog.

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LAUGH WITH BARNEY

A beauty, by name Henrietta,
Dearly loved to wear a tight sweater.
Three reasons she had;
To keep warm wasn't bad,
But the other two reasons were better.

' ' '

Twinkle, Twinkle, Little Star.
He took me riding in his car.
What we did, I ain't admittin',
But what I'm knittin' ain't for Britain.

' ' '

Sign seen on rear of a bicycle: "Motorist Don't Hit Me! You May Be on One Yourself Soon."

' ' '

Captain: The man who sneaked out of barracks last night and met a girl in the woods will step forward—COMPANY HALT!

' ' '

The despondent old gentleman emerged from his club and climbed stiffly into his luxurious limousine.

"Where to, sir?" asked the chauffeur respectfully.

"Drive off a cliff, James," replied the old gentleman. "I'm committing suicide!"

' ' '

"They say swimming is the best thing to develop poise and grace."

"Yeh. Didja ever get a close look at a duck?"

' ' '

Sign on a truck:

This truck stops for all railroad crossings, brunettes and redheads.

Will back up one-half mile for a blonde.

' ' '

A judge was pointing out that a witness is not necessarily to be regarded as untruthful because he alters a statement made previously.

"For instance," he said, "when I entered this court today I could have sworn I had my watch in my pocket. But then I remembered I had left it in the bathroom at home."

When the judge got home that night his wife said: "Why all this bother about your watch — sending four or five men for it?"

"Good heavens," said the judge, "what did you do?"

"I gave it to the first one who came; he knew just where it was."

' ' '

After having taken the farmer's wife to the asylum raving mad, somebody asked him what he thought caused it and he said, "Damn'd if I know! I have not had her off the farm for forty years."

Evolution of the automobile, according to the *Pittsburgh Press*:

1940—No running boards.
1941—No gear shifts.
1942—No tires.
1943—No car.

' ' '

She laughed when I sat down to play.
How could I know she was ticklish?

' ' '

Bus Conductor (calling from upper deck): Is there a mackintosh down there big enough to keep two young ladies warm?

Voice from Below: No, but there's a MacPherson that's willing to try.

' ' '

"The Letter"

One of the "boys" in the East Texas field reports having received the following letter:

Dear Mr. ——:

Are you interested in doing your bit for humanity?

I am a preacher of the Gospel, and have traveled throughout the country preaching against the evils and vice of this modern day, and particularly against the use of intoxicating liquors.

During the last several years, I have taken with me, wherever I went, a living example of the degradation of humanity due to this cause in the person of a Mr. Elmer Smith, who sat in front of the church in full view of all, in an extremely inebriated condition, and after seeing the effect of alcohol on him, my sermons converted many people. However, now that he has passed into the great beyond due to his ability to consume so much beverage of alcoholic content, I am forced to look for another lost soul to take his place, as I have been unable to convert nearly so many people as when he was with me.

I have a long list of names for consideration, but your recommendation has come to me on the highest authority, and, after observing you in action several times, I believe you would serve my purpose admirably.

Unfortunately, I can't guarantee your salary, but I can assure you that you will have all the liquor you can drink every night and you will have the satisfaction of knowing that you are sacrificing your life little by little for this great cause.

Will you give this offer your consideration, and let me know what you wish to do in the matter.

Yours very truly,
I am/1 2 Rev. Tom Collins.

"Well, in any case, I'll always be a brother to you."

"If I had any use for a brother I could reach under the sofa and get one now."

' ' '

"I'm all out for defense," the fat lady said as she surrendered her girdle to the Boy Scout.

' ' '

Pastor: Are you troubled with improper thoughts?

Sinner: Naw, I rather enjoy 'em.

' ' '

A social worker went to visit our local insane asylum and noted a chap in the nude sitting in a cell with his hat on.

"My good man, that's no way to be sitting around. Why don't you put some clothes on?"

"Oh . . . nobody ever comes to see me."

"Well, why do you wear a hat?"

" 'Cause you can't tell . . . somebody might."

' ' '

A short-sighted man lost his hat in a strong wind and was chasing it.

Woman: What are you doing there?

S. S. Man: Getting my hat.

Woman: Your hat! That's our black hen you're chasing.

' ' '

Executive Officer: The ship is leaking.

Admiral: Whose fault is it?

Executive Officer: It's the carpenter's fault.

Admiral: Rub his nose in it.

' ' '

Captain: Why didn't you salute me yesterday?

Private: I didn't see you, sir.

Captain: Good, I was afraid you were mad at me.

' ' '

"How about taking a little ride in the country?"

She: "Not tonight . . . I'm too tired. How about running out of gas here in town?"

' ' '

There are a lot of people who don't neck in parked cars . . . fact is, the woods are full of them.

' ' '

Doc: I can't quite diagnose your case. I think it must be drink.

Old Soak: All right, doctor, I'll come back when you're sober.

' ' '

He phones his wife several times a day.

I know several men who do the same thing.

' ' '

"How is it he never takes you to the movies any more?"

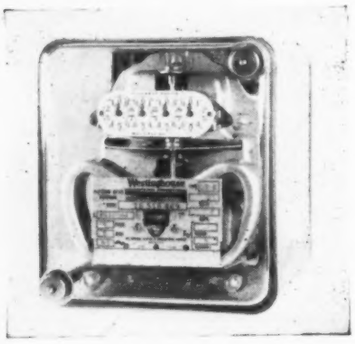
"Well, one evening it rained and we sat in the parlor."

MACHINERY and EQUIPMENT

Switchboard Watthour Meter

FOR industrial and central station use, a new line of switchboard watthour meters is announced by Westinghouse Electric and Manufacturing Company.

Known as Type CB, the units are available for metering all the various combinations of single-phase or polyphase power. Mounting styles are flush,



projection, and a detachable or plug-in construction. The detachable models can be readily removed for overall inspection and test without interrupting the circuit. All the calibration adjustments are accessible from the front when the molded glass covers are removed.

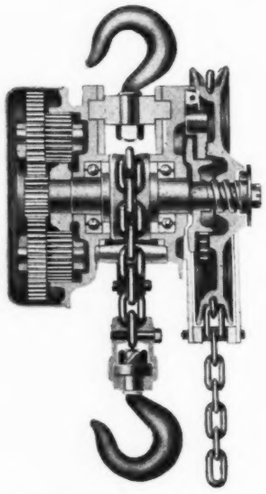
The CB single-phase meters in this line have one electro-magnet and are applicable to single-phase circuits. The CB meters for the usual 3-wire single-phase circuits have 3-wire current coils. CB-2 meters have two 2-wire elements and may be used on single or 3-phase, 3-wire circuits, and on 2-phase, 3- or 4-wire circuits. CB-3 meters consist of three 2-wire elements. They are used to meter 3-phase, 4-wire star-connected circuits and, when used with instrument transformers, to totalize combined 3-phase, 3-wire and single phase, 2-wire or 3-wire loads.

The CB-8 meters are of the two disk type and have two 3-wire electro-magnets interconnected to form a 3-current coil meter. These are used on 3-phase 4-wire star-connected service and are fully accurate wherever the voltages are not extremely unbalanced, it is stated. CB-10 meters are of the two disk type and have two separate 3-wire elements. They are used on 2-phase, 5-wire service.

Additional information may be obtained from booklet IL 42-104.1 by writing Department 7-N-20, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pennsylvania.

Improved Spur Geared Chain Hoist

AN IMPROVED, standard type, spur geared chain hoist is now being manufactured by the Coffing Hoist Company, Danville, Illinois. It is recommended by the company for many applications in practically all lines of industry where maximum speed, safety, durability, and efficiency are essential. This hoist, known as the Model Y-C, is equipped with a dust guard to protect the Weston type brake from dust and dirt. Heavy suspension plates provide unbreakable support between top hook cross-head and load sheave, it is stated. These plates also directly support the saddle for double-chain hookup, a new feature in this type hoist, and eliminate the use of a top yoke thus reducing weight and headroom and permitting the hoist to hang evenly at all times. The load sheave is mounted on two heavy precision ball bearings enclosed and protected from dust and grit.

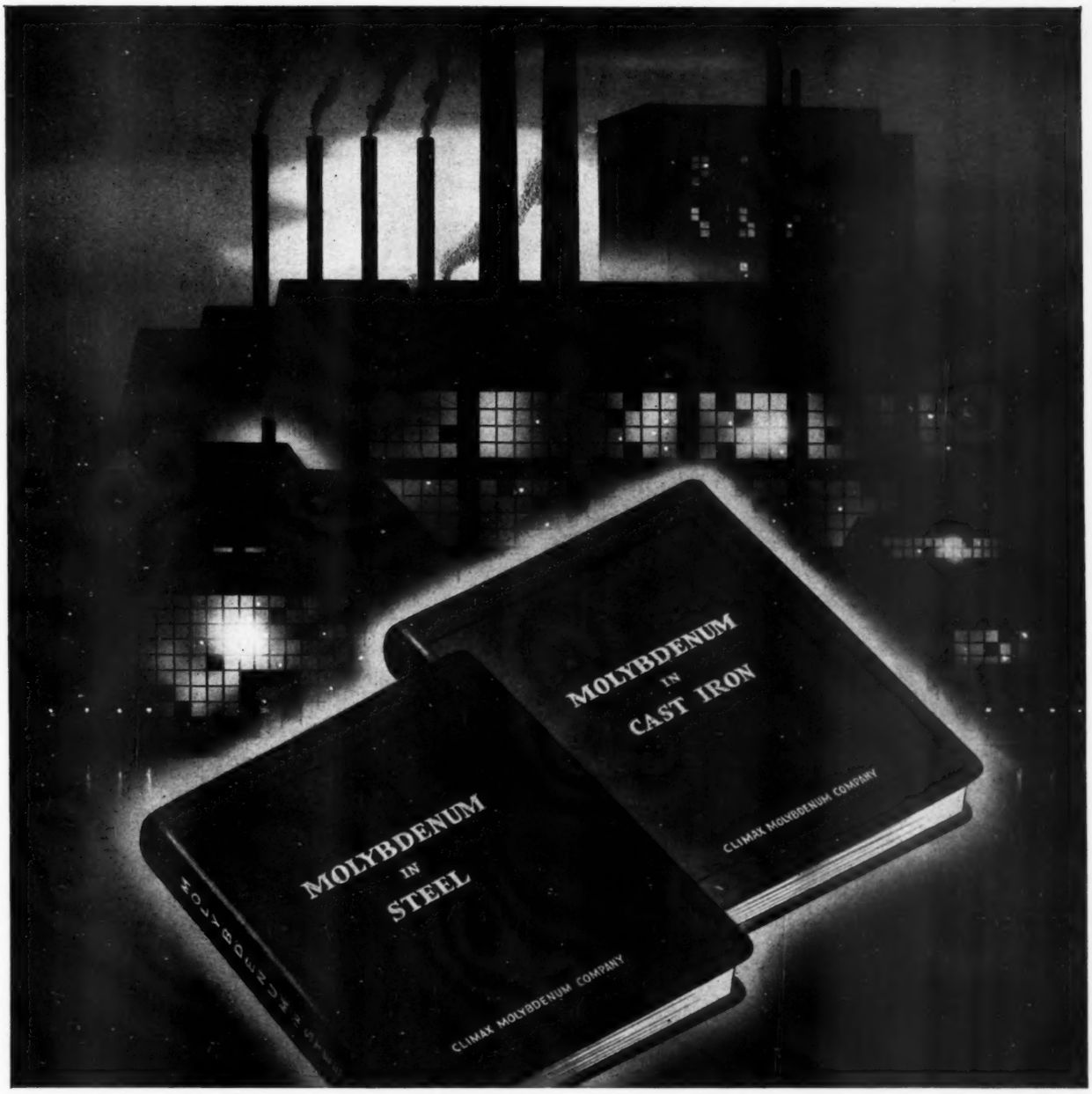


The new Model Y-C embodies many other outstanding features and is built in six capacities, ½, 1, 1½, 2, 3, and 4 tons. The manufacturer states that all capacities are factory tested at 100 percent over their rated capacity and are guaranteed against defective material and workmanship.

Series of Kelly Wipers

IN order to provide an effective kelly wiper to clean the kelly as it comes through the kelly bushing, Patterson-Ballagh engineers have introduced several new types of rubber wipers. These now include octagonal and hexagonal kelly wipers as well as the conventional square. Fittings have been developed for installation in Baash-Ross and Emsco type of kellys. The rubber wiping unit is bolted at the bottom of the kelly bushing and can be quickly removed for inspection. Arrangements can be made by purchasers of the bushings for installation of these wipers at the factories.

Details are available from the manufacturer, Patterson-Ballagh Corporation, Los Angeles, California.



PRACTICAL DATA FOR PRESENT PROBLEMS

Here are two books designed to help users of Molybdenum steels and irons to conserve all alloying elements, and possibly steel and iron, by getting the most in the way of strength, toughness and wear resistance with the lowest alloy content.

"MOLYBDENUM IN STEEL" covers the fundamental metallurgy of Molybdenum steels. Heat treatment – physical properties – applications – of a number of these steels are treated at length.

"MOLYBDENUM IN CAST IRON" covers the effect of Molybdenum in gray iron, giving suggested analyses for practical applications and detailed discussion of high strength (60,000 p.s.i. and up) irons.

Both books will gladly be sent free on request.

Climax Molybdenum Company
500 Fifth Avenue · New York City

MOLY

Byron Jackson Tongs

BY PROVIDING multiple steps for flexibility, the recently designed BJ Type B and Type C rotary and casing tongs handle a wide range of pipe sizes, requiring only the installation of the proper size latch lug jaw. Regardless of the pipe diameter, all jaws contact the pipe and exert uniformly equal pressure.

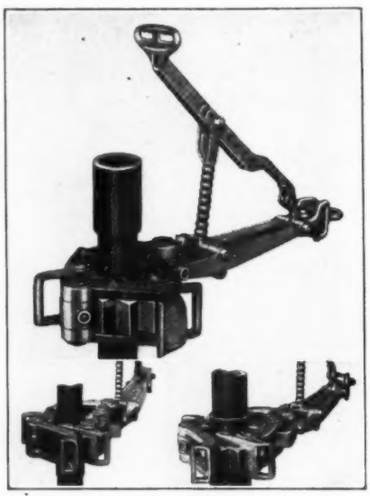
Each Type B tong can be equipped with any one of four different latch lug jaws, which fit sizes respectively as follows: 3½ in. to 5 in., 4¼ in. to 6¾ in., 6⅝ in. to 9 in., and 9 in. to 10¾ in.

Each Type C tong will fit all pipe and tool joint diameters from 2⅜ in. to 8⅝ in. when the proper size latch lug jaw is installed.

It is immediately apparent that the investment in tongs can thus be held to a minimum by having the required extra latch lug jaws on hand.

The modern design that enables these tongs to fit such a wide range of sizes, and at the same time maintain uniform contact around the pipe, provides contacting radial cam surfaces on the end of the lever and the rear face of the short jaw, and the mounting of hinge pin for the short jaw in a sliding block in the lever. The short jaw is thus held in proper position to form, in conjunction with the other jaws, a true circle for all pipe sizes within the range of the tongs.

A successful new latching mechanism is provided by equipping the latch lug jaw with two or more steps, and



Rotary and casing tongs

the strong stirrup-type latch is readily closed to the proper step for tonging the particular size of pipe being handled. The latch is held securely closed by two compression springs enclosed within the jaw and well protected. By providing two springs the force is divided, and maximum service is obtained before replacement is necessary.

A new head-and-nut type solid hinge pin is used in the Types B and C tongs, and all female bosses are recessed at top and bottom to bring both the head and nut of all hinge pins flush with the outside face of the jaws. Dowel pins are inserted through the slotted heads of the hinge pins, which are thus rigidly attached to the female hinge of the jaws.

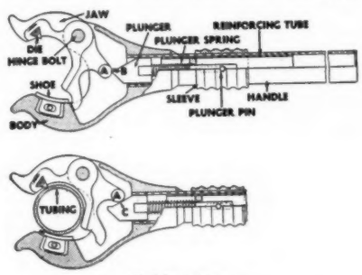
Additional features include: recessed grease gun connections for proper lubrication; a sturdy, rigid-type suspension that balances the tong perfectly, and collapses flat on top of the lever when the tong is to be transported from one rig to another; a special short lever for the Type C tong, which is ideal for clearing the girts on portable rigs.

Due to utilizing a different principle, the BJ Type T tubing tong can be applied with a "stab on" motion, and will not thereafter droop, slide down, or fall off when it is passed around or ratcheted, the manufacturer states. It also can be applied by holding the plunger in a retracted position until the tong is closed around the pipe, then allowing the plunger to move forward, thus eliminating danger of a spark

EMBODYING all the refinements of design and construction, learned in 75 years of gauge making, Marsh Gauges give you the highest possible degree of accuracy . . . and, even more important, the stamina to maintain that accuracy under the toughest conditions to which a gauge can be subjected.
If you know Marsh Gauges you know that it takes more to knock them out of adjustment than any other make. But unlike other gauges they have the Marsh "Recalibrator" that restores original accuracy *throughout the entire scale* with the twist of a screwdriver.
There is a Marsh Gauge for practically every service encountered in the oil industry.
JAS. P. MARSH CORPORATION
2097 Southport Ave., Chicago, Ill.
MARSH GAUGES

from the metal-to-metal contact of the die and pipe. The upper illustration shows the hinged jaw in the position it takes when the tong is removed from the tubing. When the plunger is retracted into the handle the rounded portion, A, of the jaw is held on the flat end of the plunger, B, by the force exerted by the compressed plunger spring. When the tong is "stabbed on" the tubing strikes against the inner face of the jaw with sufficient force to move the rounded portion, A, off the flat, B, at the end of the plunger. The plunger spring is then released and the plunger moves forward until the rounded portion, A, is in position on the wedging face of the plunger, as shown in lower view.

The strength of the plunger spring is sufficient to hold the tong in posi-



Tubing tong

tion safe from sliding down or falling off the tubing, but the tong is easily ratcheted.

To remove tong from tubing the plunger spring is pulled back to retract the plunger, and the slidably mounted shoe assists in releasing without sticking. The rounded portion, A, then takes the position shown in the upper view, holding the tong open and ready for use.

The tong also is successfully used as a lay tong for pipe line or refinery service, when the plunger is equipped with a long stem that extends to the end of the handle, and a hand grip on the end of the stem that slides in and out of the handle end and does not prevent the use of a snipe.

Complete information can be obtained by addressing Byron Jackson Company, at Los Angeles, California, Houston, Texas, or New York, New York.

Skinner-Seal Bomb Crater Clamp

GAS and water companies in danger areas will be interested in a new device for quickly repairing mains where a gap has been blown out by an explosion. The new clamp, known as the Skinner-Seal Bomb Crater Clamp, makes a tight, lasting connection between the ends of the broken main and a random piece of steel pipe cut to appropriate length to fill the space.

Developed by the M. B. Skinner Company, South Bend, Indiana, at the request of a prominent West Coast gas company, the new adapter makes use of standard Skinner-Seal Bell Joint Clamp parts to splice a proper length

of steel pipe to fill in the gap in broken main, with minimum delay. The illustration shows how the connection is made between the main and steel pipe at each end of the gap. The left end makes connection with main; right end makes connection with steel pipe. Note how flanges, welded to center tube, act as anchor rings for bolts.

Of interest, also, in connection with air raid precautions, the Skinner-Seal Split Coupling Clamp quickly repairs breaks in the main that are apt to occur for some distance on each side of the bomb crater.

According to The M. B. Skinner Company, they are in a position to make prompt deliveries to gas and water companies in probable air raid zones.

No... But "For The Duration" You Should Handle Them as Such

A friend of ours—superintendent for a major company in the Mid-Continent—calls his field men together every now and then and says: "All sucker rods are made of glass! That's the way we want you to handle them. Just like they were glass."

Although he's been saying this for years, his story has new meaning today. America's armed forces need oil and steel. You can help fill both of these needs by using every precaution in handling and care of rods now in use. You'll find the quality of Jones Sucker Rods a big help in your efforts to do this.

Sucker rods made of glass? Some substitute material? We'd like to make rods of some different material and help save steel, too! Right now there is no substitute material for sucker rods. This is a problem for Jones research—the same research that gave the Oil Country the first all metal sucker rod and streamlined forging.

The S. M. JONES Co.
JoneSuckeRods
General Office and Factory, Toledo, Ohio — Sales Office, McBurney Bldg., Tulsa, Okla.

Sandblast Hose

AGAIN putting to practical use its comparatively recent research on electrically conductive rubber and synthetic rubber compounds The B. F. Goodrich Company, Akron, Ohio, announces a new sandblast hose employing these principles.

The new hose has been designated "B.F.G." Because of its success in this service the company's previous antistatic sandblast hose, which used an internal wire construction for dissipating static charges, has been discontinued.

There is no wire used in the new "B.F.G." sandblast hose. The rubber compound used carries away the static electricity as fast as it forms.

Laboratory tests made on conventional sandblast hose of excellent make and quality showed that the rubber compounds used in them had a resistance exceeding one quadrillion ohms per centimeter cube, whereas the resistance of the compound used in the new B. F. Goodrich hose is only 3000 ohms per centimeter cube, the manufacturer asserts. For the high voltages of static electricity the compound is practically as good a conductor as metal, the company's engineers point out.

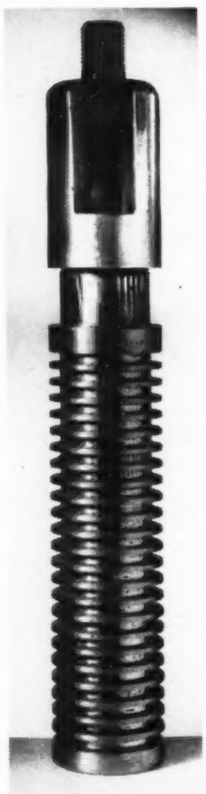
After laboratory tests on the new hose were made, several thousand feet were placed on test carrying high-velocity sand on a large construction job in the far west, where the ordinary highest quality sandblast hose was not able to carry away the electricity and the hose could not be handled by the operator. The new hose performed its task so well under difficult conditions that thousands of feet of it were ordered. It not only carries away the high static charges, but is proving abrasion-resistant to the sharp sand particles, the makers state.

The new hose is made in four-ply construction, with ¼-in. tube, in sizes ranging from ¾ in. to 3 in.

4 Years Service . . .
Still as Good as New

"*This Martin Plunger Body* and two smaller ones saved us over 150 pulling jobs on our J. T. Wilson Lease near Bristow, Oklahoma, in four years of service, and prolonged the life of the lease at least three years."

(Signed) D. B. MASON
Independent Producer
Tulsa, Oklahoma



The "good-as-new" condition of these three Martin bodies proves the durability of the Martin Plungers. You not only conserve valuable materials vital to our National Defense—you actually save time, money and production when you use Martin Plungers.

Only Martin Plungers have the one-piece "fluid-proof" bodies and "compensated" precision packing rings.

Sold Only Through Supply Stores
See Page 1551, Composite Catalog

Field Representatives:
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LYNN C. HOLLOWAY, Houston, Texas
J. WALTER WADE, Olney, Ill.
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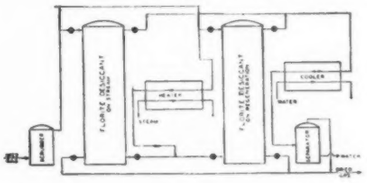
E. M. SCAGGS, Longview, Texas
F. M. WILSON, Wichita Falls, Texas
J. B. ALEXANDER, Odessa, Texas

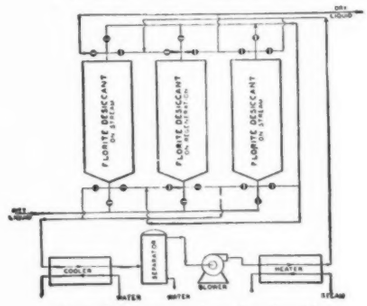
JOHN N. MARTIN
Manufacturer
11 W. Brady St. Tulsa, Okla.

Florite Desiccant

FLORITE Desiccant, a new granular drying agent for gases and liquids, has been placed on the market by the Floridin Company, 187 Liberty Street, Warren, Pennsylvania. Florite Desiccant not only has been accepted as completely satisfactory in a variety of industrial processes requiring bone-dry



(A) *Dehydration plant for gases*



(B) *Dehydration plant for liquids*

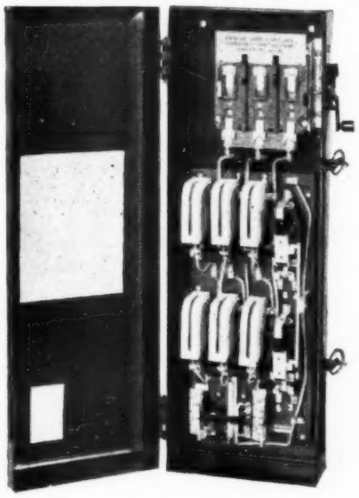
gases and liquids, but has also proved economical in many installations where high drying efficiency is not ordinarily demanded, the manufacturers assert. Among the products now being successfully dehydrated are natural gas, propane, gasoline, air, nitrogen, and carbon dioxide. It may also be used in breathers for storage tanks and electrical transformers, to dehumidify air in air-conditioning systems, and to dehydrate refrigerants.

The outstanding characteristic of Florite Desiccant is its ability to maintain a high drying efficiency under exacting conditions. It adsorbs water instantly and will not swell, disintegrate, or appear wet at the end of an adsorption cycle, it is stated. It is hard, stable, non-corrosive, and non-poisonous. Flo-

rite Desiccant selectively adsorbs 4 to 20 percent of its weight in water, depending on the particular application, and is regenerated by heating to 300-350°F.

A-C. Combination Magnetic Reversing Starters

A NEW line of a-c. combination magnetic reversing starters for squirrel-cage induction motors has been announced by the General Electric Company, Schenectady, New York. Also suitable for the primary control of wound-rotor motors, these single-unit starters consist of two mechanically interlocked reversing contactors,



a two-pole overload relay, and either a circuit breaker or a fusible or non-fusible motor-circuit switch.

The starters are designed to provide full-voltage reversing control and short-circuit protection in one unit to save space and installation time, to provide greater protection for equipment and operators, and to improve appearance. They are completely wired and ready to operate after connection of incoming power lines, outgoing motor lines, and control circuit. The line includes NEMA size 0 to 4 starters covering single-phase and 3-phase motors in sizes to and including 100 hp. at 440 or 550 volts.

The fusible forms combine a manually operated motor circuit switch with clips for cartridge-type fuses. Under short-circuit conditions, the fuses provide fast interruption of circuits having maximum available current of 10,000 amp. at rated voltage. The motor circuit switch is operated from the outside of the enclosing case by a handle so interlocked with the cover that the switch must be in the off position before the cover can be opened. This makes it impossible for an operator to attempt to make adjustments on the inside of the enclosure without first opening the circuit.

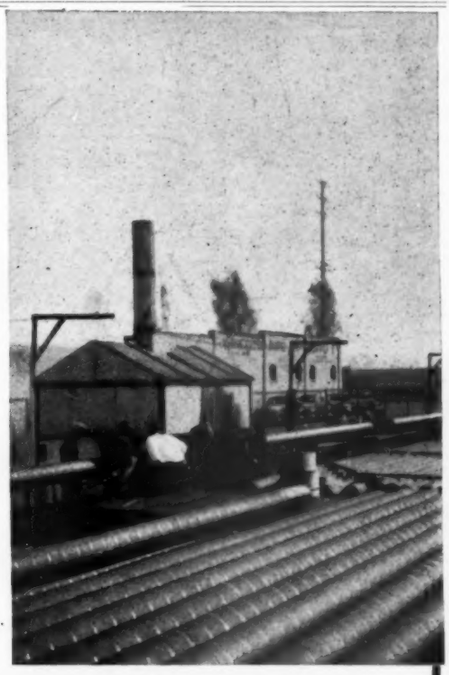
The circuit breaker forms provide simultaneous tripping of all phases on short circuits, and have a trip-free mechanism that prevents holding the breaker closed under short-circuit conditions. The breaker can be reset after operation by returning the operating handle to the off position. Breakers in the smaller ratings have bimetal thermal trip units only and the larger breaker ratings have interchangeable bimetal thermal trips as well as magnetic instantaneous trips.

When the starters are used in conjunction with a momentary contact push-button station, undervoltage protection is provided by an electrical interlock on each contactor. An isothermic temperature overload relay protects the motor from dangerous overheating caused by overloads or other conditions.

The contactors have layer-wound coils, molded arc chutes, and readily accessible contacts, and are mechanically interlocked so that only one contactor can be closed at a time. The starters are available in Type 1 general-purpose enclosures, Type 1A semi-dust-tight enclosures, Type 5 dust-tight enclosures, or Type 4 water-tight enclosures.

Reilly

Primer and Pipe Enamel



. . . MAINTENANCE COSTS Reduced to the Minimum

The best way to insure low maintenance charges for water, gas and oil pipe lines is to provide *dependable protection against rust and corrosion* due to soil acids and electrolysis. Dependable protection means pipe coatings which bond firmly to the metal, and safely withstand temperature variations without sagging in extreme heat or cracking under severe cold. Such coatings are REILLY PRIMER and PIPE ENAMEL. They are easy to apply, and are comparatively low in cost. Write for literature.

Reilly COAL TAR PRODUCTS

REILLY TAR & CHEMICAL CORPORATION

Executive Offices: Merchants Bank Building, Indianapolis, Indiana

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FIFTEEN · PLANTS · TO · SERVE · YOU

Seismograph Dynamite Cartridge

A NEW cartridge for seismograph dynamite that will provide a strong, rigid column and make unnecessary stringing, lathing, taping, and pegging commonly used in loading a hole, has been developed by the Explosives Department of Hercules Powder Company, Wilmington, Delaware.

The cartridge, known as "Spiralok," consists of dynamite packed in a strong paper shell equipped with a spiral thread. This shell screws into a stout spiral-grooved sleeve. Each cartridge is packed in its own sleeve of the same length. In loading, a sleeve is screwed over the two halves of adjacent cartridges until they butt together. A series of these cartridges thus joined provides a complete seismograph shot charge in a rigid column.

Simplification of the preparation of a charge enables a crew to shoot more shotpoints in a day, reducing the time required to detail a prospective structure, it is stated.

The difficulties arising from a break in the column while loading can be largely eliminated by the use of the new cartridge, it is asserted.

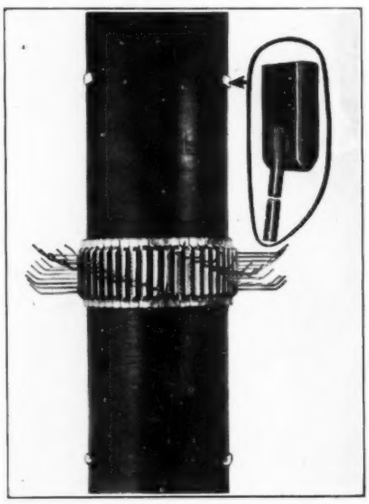
Field tests have shown that the rigid column provided by the cartridges makes it possible to load bridged, sandy, and cavernous holes without a break. Crews have loaded charges varying from 15 to 40 lb. in a continuous column in such holes without difficulty. These tests showed that the "Spiralok" cartridges prevented the buckling that develops so frequently in cavernous holes.

The rigidity of the column permits a longer charge of dynamite to be prepared and started down the hole. Often a full charge can be loaded with one round trip of a loading rig.

The column may be primed anywhere along its length. If primed along the side of the column, the sleeves are turned back, the cap inserted, and the lead wires are half hitched over the cartridge and strung along outside the sleeve. The sleeves are then screwed back together until firmly butted against each other, providing additional protection for the cap.

Welding Blocks for Wall-Cleaning Guide Installation

B AND W, Inc., Houston, Texas, and Long Beach, California, announce the development of welding blocks for B and W wall-cleaning guide installations. The use of these



blocks speeds up the casing operation, it is stated.

These new blocks are spaced 14 in. apart vertically, and are welded to the casing to restrict the travel of the wall-cleaning guides, but allow sufficient travel to release the slips without scratching as each joint is run. The blocks are 3/16 in. by 3/8 in. by 3/4 in. long, with a wire handle that is cut off with the arc as each block is welded to the casing.

The wall-cleaning guides are packed three to the carton, and six welding blocks per guide are supplied.

2400 Work Hours—Against 360

On large oil company tells us that COLMONOY coated pump sleeves run 2400 hours, pumping hot oil at 900°, with pump running at 3600 R.P.M. Other sleeves tested ran only 360 hours.

COLMONOY is playing an important part in oil production and refining operations in the United States. Pump sleeves, plungers, rings, wash pipes and many other kinds of equipment used in the oil industry are particularly subject to excessive corrosion and abrasion.

COLMONOY Keeps Them on the Job.

Worn out parts, COLMONOY coated, will outwear and outperform new, unsurfaced parts many times over.

Investigate COLMONOY Today

Catalog mailed on request.

WALL-COLMONOY CORP.

Sixth Floor, Buhl Building, Detroit, Michigan

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123 W. Philadelphia St. WHITTIER, CALIF.

COLMONOY

Hard Surfacing Alloys and Overlay Metals

H. G. Texter Transferred By Spang Chalfant, Inc.

H. G. Texter, who has been connected with the Tulsa, Oklahoma, office of Spang Chalfant, Inc., for many years as sales engineer, has been transferred to the Ambridge, Pennsylvania, plant of the company. He will be engaged in engineering work in connection with the company's large war production program. He expects to be employed in plant work for at least one year.

Texter is widely known in the petroleum industry, having visited most of the fields in the United States and several foreign countries.

Someone in the organization will replace Texter on sales engineering work.

W. L. Childs of Reed Roller Bit Company Passes Away

W. L. Childs, vice-president and general manager of the Reed Roller Bit Company, Houston,, Texas, died Monday, March 23, from a heart attack. Company officials said Childs had overtaxed himself working on defense

W. L. CHILDS

orders for the government. When the government instituted its defense program some months ago, the Reed company was separated into two divisions, one to continue its manufacture of oil-field equipment, and the other for making transmissions for military tanks. Childs concerned himself with the latter. He suffered one heart attack Sunday while making an inspection trip of Houston production plants with Lieut. Gen. William S. Knudsen, procurement officer for the United States army. Late Monday he was stricken in his office and was removed to a nearby clinic where he was treated, and, while arrangements were being made to transfer him to a hospital, passed away.

Childs would have been 60 years old next June 17, having been born at Union Grove, Illinois, in 1882. He went to Texas in 1905 and worked in Beaumont with the Southern Pacific Railway until January, 1907. At that time he moved to Houston to work for the Gulf Pipe Line Company, for which he was successively assistant purchasing agent and purchasing agent. In December, 1917, he was made secretary-treasurer for the Hughes Tool Company. In 1921 he went into business for himself, and four years later became vice-president and general manager of the Reed Roller Bit Company.

Childs was active in the affairs of the petroleum industry as well as in civic affairs. In 1933-34 he was president of the Petroleum Equipment Suppliers Association, which he helped organize and of which he had been a director since its inception. He was president of the Houston Chamber of Commerce in 1938, had served on its board of directors since 1930, and was a member of its executive committee at the time of his death. He was potentate of Arabia Temple Shrine in 1928, had served as an official of the Community Chest, and maintained active membership in numerous organizations.

Survivors are his widow, Mrs. Stella Childs; a son, Lt. W. L. Childs, Jr.; a daughter, Miss Phyllis Childs; a brother, Clarence Childs, Sioux City, Iowa, and a sister, Mrs. Eleanor Knox, Morrison, Illinois.

Job Experience Eliminates costly experiments
The "on-the-job" experience of Twin Disc Clutch Company's staff of field engineers combined with competent factory engineering design eliminates costly, time-consuming experiments with untried designs, untested ideas . . . that's why we believe job experience is one of the most valuable assets a clutch specialist has to offer the builder of high grade oil-field equipment.
The Twin Disc Clutch Company's Engineering Department is ready to share their 24 years of experience in building clutches to fit the job with any oil field manufacturer who has a clutch problem. Write Engineering Department, TWIN DISC CLUTCH COMPANY, 1329 Racine Street, Racine, Wisconsin.
BELOW: Heavy-duty, enclosed-type Model E Twin Disc Clutches are available in 14" to 42" sizes in single or two-plate assemblies.
RIGHT: Twin Disc Power Take-offs are suitable for engines having up to 285 hp. output.
BOTTOM: Two 185 hp. Waukesha engines equipped with Twin Disc Power Take-offs provide power for a rig operated by the Noble Drilling Co., Apache, Oklahoma.
TWIN DISC
CLUTCHES AND HYDRAULIC DRIVES
REG. U.S. PAT. OFF.

Kobe, Incorporated, Announces Executive Changes

Executive changes announced by C. J. Coberly, president of Kobe, Incorporated, include the appointment of A. M. Smith as chief engineer, C. M. Rader as general sales manager, and H. K. Browning as division manager in charge of Mid-Continent activities. Smith and Rader will headquarter at the company's general offices in Huntington Park, California. Browning will continue to make his headquarters in Oklahoma City, Oklahoma.

Smith has had long and practical field experience in hydraulic engineering, which particularly fits him for the many new problems created by the widespread use of the company's products. After completing his studies at Stanford University, Smith was commissioned an Ensign in the United States Naval Reserve. He joined C. J. Coberly in production and experimental work with the Purox Company of California at the termination of the war. From 1921 to 1929 he was active in hydraulic power construction and development work in California and in 1929 became actively engaged in the development of hydraulic machine tool feeds in Los Angeles and Detroit. Smith became associated with Kobe, Incorporated, in 1934 and since that time has been directly concerned with the service and development of hydraulic pumping equipment. In his new capacity he will have complete responsibility for the research, design, metallurgy, and product engineering of all the company's products.

A. M. SMITH

Rader was graduated from the Civil Engineering School of the University of Minnesota, after which he entered the officer's training course at Fort Snelling, Minnesota, later serving with the 20th Engineers in France during 1917 and 1918. At the termination of the war he joined the Mid-Western Refining Company as district petroleum engineer for Colorado, Wyoming, and Montana. After a brief experience in general engineering practice in Florida, Rader joined the Indian Territory Illuminating Oil Company in 1925 as petroleum engineer at Seminole, Oklahoma. He later moved to Oklahoma City as assistant to the vice-president and general manager of the same company. He joined the Phillips Petroleum Company in 1931 as petroleum engineer in Oklahoma City, at the time when the first of many difficult pro-

C. M. RADER

Compare
GRIZZLY
Performance
ON Any WELL
IN Any FIELD
If you have any doubts regarding their performance and long life . . . check the records of Grizzly Rotary Brake Blocks on any well, in any field . . . Grizzly performance is outstanding, regardless of well or drilling conditions, and is a good measure of value with which to make comparisons . . . Be sure! You can't go wrong on brake lining if you check actual performance records at the rig.
Investigate the Grizzly Brake Block Band Exchange too . . . your assurance of brakes that fit, superior braking performance, long life, and maximum economy. Ask your supply dealer, or any Grizzly branch.
GRIZZLY MANUFACTURING COMPANY
Formerly E. M. Smith Co.
Plants: Los Angeles, California Paulding, Ohio
Complete Stocks Maintained in our Warehouses At:
407 Velasco St., Houston, Texas 1008 S.E. 29th St., Oklahoma City, Okla. 1621 E. Yellowstone, Casper, Wyo.
Export Office: Continental Emsco Co., 30 Rockefeller Plaza, New York, N. Y.
Distributed by Leading Supply Companies
GRIZZLY ROTARY BLOCKS

duction problems presented themselves in the Oklahoma City field. In 1937, Rader, having become interested in the possibilities of hydraulic oil well pumping, became associated with Kobe, Incorporated, as Mid-Continent division

H. K. BROWNING

manager and has been responsible for the company's growth in these fields since that time. In his new capacity as general sales manager he will be responsible for all field operating activities and sales—both foreign and domestic—in connection with the company's various products.

Browning attended the School of Engineering of Cornell University, after which he was associated for several years with the A. M. Byers Company of Pittsburgh, Pennsylvania, holding the position of manager of oil country sales, in which position he was quite active in technical sales work. Interest in pumping and corrosion problems led to his association in 1934 with the S. M. Jones Company as sales manager, a position he held for five years.

In addition to the new responsibilities created by this appointment, Browning will continue actively in charge of the company's entire advertising and promotional program in connection with all its products.

C. I. Collins Joins Wickwire Spencer Steel Company

E. C. Bowers, president of the Wickwire Spencer Steel Company, announces that Carl I. Collins, elected on March 26 to the board of directors of the company, will be named executive vice-president at the next meeting of the board.

After graduating in mechanical engineering from the Georgia School of Technology, Collins entered the steel business with the Atlanta Steel Company. Prior to the entrance of the United States into World War I, he was superintendent of the loading plant of the United States Cartridge Company at Marner, New Jersey. In 1917, he joined the United States Army Air Service, in which he later became a flying instructor. Subsequently, he was attached to the General Headquarters Staff at Chaumont, France.

After the war he joined the Hyatt Roller Bearing Company and in 1923 he became plant superintendent and later assistant to the vice-president of the Morris and Bailey Division of the Oliver Iron and Steel Corporation.

After acquisition of the Oliver company by the American Steel and Wire Company in 1930, Collins was made general manager of the Morris and Bailey Division and, in 1933, was named general superintendent of the Cuyahoga Works where he had charge of the billet, rod, wire, and cold rolled strip mills and auxiliaries.

In 1935 he was made manager of operations of the Worcester district of the American Steel and Wire Company with mills in Worcester, New Haven, and Trenton, New Jersey. He is resigning this position to join Wickwire Spencer.

"CLEVELANDS" Have What It Takes to Deliver Under MOST ADVERSE CONDITIONS

A balanced combination of all the features which have been found most desirable in pipeline ditching the "CLEVELAND MODEL 140" is built to perform and to endure. On the straightaway, in "good going" the "140" leaves nothing to be desired in the way of speed and performance. It stands supreme in its ability to get the work done quickly and at absolute rock-bottom cost.

But built into every "CLEVELAND" is a big plus value that enables it to deliver master performance under the most adverse conditions, and pile up real savings when the going gets tough.

The illustration above shows how the "140" often climbs out of tough holes unaided, because the digging wheel can be reversed and used as as a traction wheel to help the crawlers at a coordinated speed. The illustration below shows a "140" going through a frozen creek bottom and up a bank, without a hitch, while digging at maximum depth.

"CLEVELANDS" deliver this superior performance because in them correct designs join hands with "tops" in Quality. You can't miss when you pick "CLEVELANDS" for your ditching jobs. Write for specifications and details.

THE CLEVELAND TRENCHER COMPANY
20100 ST. CLAIR AVE. "Pioneer of the Small Trencher" CLEVELAND, OHIO
"CLEVELANDS" Save More... Because they Do More

Appoints Advertising Manager

The Cummins Diesel Engine Corporation of New York, 1120 Leggett Avenue, New York City, announces the appointment of Charles D. Cavett as advertising and sales promotion manager.

Cavett has been on the copy staff of Spencer W. Curtiss, Inc., Indianapolis industrial agency, for the last three years and prior to that was engaged in newspaper and publicity work in Ohio, California, and New York.

Employees and Stockholders Together Discuss Company's Operations

Macwhyte Company, Kenosha, Wisconsin, in keeping with its usual custom, invited all their employees and stockholders to an annual dinner, March 21, 1942. It has become a tradition at Macwhyte Company that once a year the entire family breaks bread together to discuss the progress of the company's business.

Twenty-nine colored charts flashed on a huge screen, thoroughly explained by H. E. Sawyer, vice-president and treasurer, revealed such intimate details as company shipments, current assets, fixed assets, liabilities, taxes, profits, and losses. "These charts," said Sawyer, "give you more information than a concern usually supplies to their banker."

George S. Whyte being presented with plaque

"This is the largest gathering we have ever had," said Jessel S. Whyte, president and son of its founder. "I regret that due to the most important task of keeping production rolling that we could not have all of us together for this evening meeting. We had a similar meeting this noon for those who are working tonight."

The day before the meeting, George S. Whyte, board chairman and founder, celebrated his 75th birthday. The family took advantage of the occasion and presented their "grand ol' man" with a handsome plaque, designed by employees.

Service certificates were awarded to those who completed 5, 10, 15, 20, and 25 years of company service, by Jessel S. Whyte. Twenty-five-year men also received gold watches.

There was a moment of reflection in honor of those family friends who had passed into the Great Beyond during the year, by R. B. Whyte, vice-president in charge of operations.

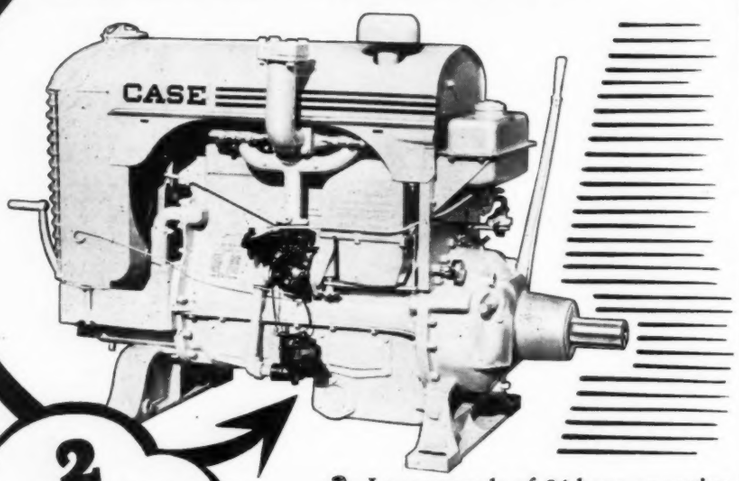
There were 35 who had left for the armed forces, and their names and locations were read so that all might know about them.

Tube-Turns Opens Houston Office

On April 1 Tube-Turns, Inc., Louisville, Kentucky, manufacturers of welding fittings and forged-steel flanges, opened a branch office in Houston, Texas. The new office is in Room 1707, Commerce Building. W. B. Whenthoff, formerly in charge of the Tube-Turns office in Tulsa, Oklahoma, is manager.

Something New for Oil Pumping

Extra Endurance *in All Weather*



2 Brand-New Models

DISTRIBUTORS

Southwest Equipment Co.
Dallas and Kilgore, Texas

Leland Equipment Co.
Tulsa, Oklahoma

Long records of 24-hour operation ... two years on original rings and oil consumption still low ... three years with nothing new but plugs and fan belt ... five years and still going strong on first ring renewal ... made Case oilfield engines famous. Now there are new models built to beat those records. They have wider margins of cooling capacity to cope with hotter weather ... improved oil pumps, strainers and distribution ducts for positive lubrication under colder conditions ... more perfect protection against dust and moisture. Let distributors furnish full information. J. I. Case Co., Racine, Wis.

CASE

Oil Field Engines

Herbert Allen Elected Vice-President Cameron Iron Works

Herbert Allen has been elected a vice-president of Cameron Iron Works, Inc., effective February 17. In this new position Allen exercises executive supervision over engineering, inspection,

HERBERT ALLEN

and manufacturing. In addition to his duties with Cameron Iron Works, he will continue as chief engineer of Abercrombie Pump Company.

Allen received a B.S. degree in mechanical engineering from Rice Institute in 1929. He entered the employ of Abercrombie Pump Company in 1931 and was made chief engineer of Cameron Iron Works in 1935.

W. E. Geiser Made District Manager By Tube-Turns

Tube-Turns, Inc., Louisville, Kentucky, manufacturers of welding fittings and forged-steel flanges, announces the appointment of W. E. (Bill) Geiser as district manager of their Philadelphia office in the Broad Street Station Building. Geiser has been connected with Tube-Turns since 1929.

G. L. Crawford Promoted by Wickwire Spencer

E. C. Bowers, president of the Wickwire Spencer Steel Company, New York City, announces the appointment of Gordon L. Crawford, previously sales manager of the Buffalo district, as assistant general sales manager with headquarters in New York. Crawford will continue as sales manager of the company's structural products division.

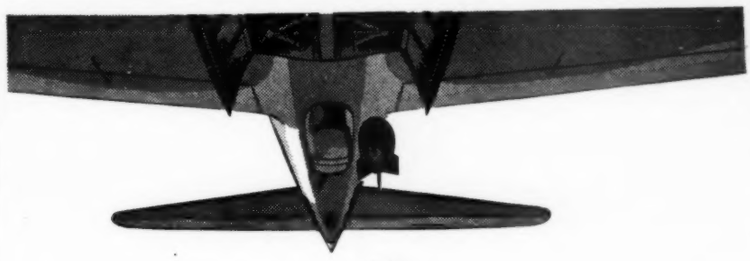
After studying mechanical engineering at Purdue University, Crawford joined the engineering staff of the Indiana State Highway Commission. In February, 1927, he became a salesman for Wickwire Spencer Steel Company in Chicago, serving there and in Tulsa until 1935 when he was transferred to the sales office in New York. He became district sales manager of the Buffalo district in May, 1940.

Radioactivity Well Logging Price Reductions Announced

A substantial reduction in the price of radioactivity well logging through casing in all fields has been announced by Lane-Wells Company, according to M. E. Montrose, vice-president and general sales manager.

"The whole-hearted acceptance of this service by oil-well operators in nearly all areas has made it possible for us to keep our field units busy most of the time," Montrose states. "Lane-Wells, in line with its policy of providing the best possible service to the oil industry, has made price reductions on radioactivity well logging consistent with the increased use of the service in all territories."

Radioactivity well logging records formation characteristics in open hole or through as many as three strings of casing. It is principally used to locate cased-off producing zones in wells drilled before electrical logging of open hole was generally used.



AIR-MAIL FOR ADOLF!

When that special-delivery bomb drops on Berlin, it will probably be marked "Made in U. S. A."

No other country can compare with America's war production, now that we're really rolling. No other has the men, the machines—or the *electric power.*

It takes a tremendous lot of power to turn the wheels that turn out tanks, planes and ships for all the United Nations—but America is power-*full.*

You can thank the men and management of America's electric companies for that. They looked and planned ahead. They were really *ready* when war came—with more electric power than Germany, Japan and Italy *combined.* They were able to meet sudden military and industrial demands all over the map.

Here is a business which, like the oil business, was *built* the American way — by local enterprise and individual investment—dedicated to *defending* the American way *until the last bit of air-mail has been delivered to the last dictator!*

DEPENDABLE GULF STATES UTILITIES CO. PUBLIC SERVICE

General Offices—Beaumont, Texas, and Baton Rouge and Lake Charles, Louisiana

Whiteford and Arnold Promoted by British American

A. L. Ellsworth, president of The British American Oil Company, Ltd., announces the election of W. K. Whiteford as president of The British American Oil Producing Company and The Toronto Pipe Line Company. H. C. Arnold succeeds Whiteford as executive vice-president in charge of the American operations of both the producing and pipe line companies. These changes are effective as of January 1, 1942. Whiteford also becomes a director and an executive vice-president of The British American Oil Company, Ltd., the parent company.

During the last seven years The British American Oil Producing Company has extended its operations to embrace the Mid-Continent, Gulf Coast, Rocky Mountain, and California producing areas. Settled production of crude oil during this same period has increased sixfold, officials of the company state. The Toronto Pipe Line Company operations similarly were expanded until today they cover purchase and transportation of crude in the East Texas field, Seymour pool of North Texas, Cut Bank field, Montana, and the Keens-

W. K. WHITEFORD H. C. ARNOLD

burg area in Illinois and Indiana. Whiteford's elevation to the presidency of the American companies and his appointment to the board of the parent company, with his headquarters in Toronto, is intended to facilitate further expansion of United States activities and contribute to the continued success of The British American Oil Producing Company and The Toronto Pipe Line Company, whose head offices are in the Philtower Building, Tulsa, Oklahoma.

H. C. Arnold, successor to Whiteford in the United States, came into prominence as one of the country's outstanding oil geologists with his discovery of the northern extension of the prolific Oklahoma City field and the first commercial production in Baylor County, Texas.

Arnold, a Kentuckian by birth, spent most of his boyhood in Claremore, Oklahoma. He attended the University of Oklahoma and after his graduation served at different times with several Mid-Continent oil companies as geologist. In 1935 he joined The British American Oil Producing Company to organize the Geological Department. In 1937 he was placed in charge of the Land as well as the Geological Department and in 1939 was named vice-president of both The British American Oil Producing Company and The Toronto Pipe Line Company. His appointment as executive vice-president in charge of United States operations of both companies followed this year.

Southwestern Gas Measurement Short Course

The 18th Southwestern Gas Measurement Short Course will be held at the University of Oklahoma, Norman, Oklahoma, on April 21, 22, and 23.

During the Short Course a general meeting will be held each morning and

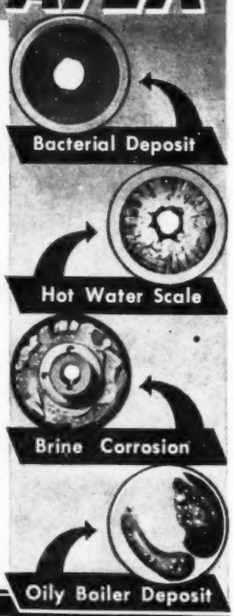
what WE READ in WATER

There are a great many stories that can be read in the various samples of water we receive. They tell of scale and corrosion in varying degrees of destructiveness. Water for cooling systems, steam and return systems, refrigerating brines . . . each has its particular story. Power plants, petroleum industries, process industries, public buildings and transportation industries . . . all have their problems.

Let us study these problems for you and tell you how Chrom Glucosate, Phospo Glucosate, and many others of our Haering products can correct these conditions, saving your materials and increasing the production of your plant.

Write for these interesting booklets:

"Organic Methods of Scale & Corrosion Control"
"Cooling Waters" • "H-O-H Lighthouse Reprints'
"The Solution of Your Proportioning Problem"
and other booklets on water treatment for Power Plants, Refrigeration Plants, Petroleum Industries, Process Industries, Public Buildings, and Transportation Industries.



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topics of interest to all will be discussed. The afternoons have been set aside for classes covering a wide variety of subjects but all relating, directly or indirectly, to gas measurement.

Among the prominent men who will speak before the general assembly are Burt R. Bay, president, Northern Natural Gas Company, and Judge Reford Bond, chairman of the Corporation Commission of Oklahoma.

The morning of April 23 has been set aside for the discussion of the fundamental principles involved in all phases of gas metering and regulating practices. In selecting subjects for the 48 afternoon classes, the committee has been ever cognizant of the problems facing the gas industry due to the war. Many fundamental subjects will be offered for the benefit of the hundreds of men who have been employed in gas measurement work in recent months. There will also be advanced classes for the more experienced men. The instructors are well qualified to teach their subjects and each will allow ample time after the presentation of material for discussion, which always adds to the richness of the program.

C. E. Terrell, Southern Natural Gas Company, Birmingham, Alabama, chairman of the Exhibits Committee, announced that 19 companies will have educational exhibits on display.

Chairmen of other committees besides Terrell are: G. W. McCullough, Phillips Petroleum Company, Bartlesville, Oklahoma, general chairman; Max K. Watson, Canadian River Gas Company, Amarillo, Texas, Program Committee; Local Arrangements and Banquet, Dean W. H. Carson, College of Engineering, University of Oklahoma; Registration and Publicity, Miss Kate A. Niblack, secretary, Oklahoma Utilities Association, Oklahoma City; Practical Methods, E. C. McAninch, Oklahoma Natural Gas Company; Publication, Earl Kightlinger, Arkansas Louisiana Gas Company, Shreveport.

SAE Summer Meeting May 31 to June 5

Geared to the most intensive series of technical discussion on war engineering projects ever staged, the Society of Automotive Engineers will hold its Annual Summer Meeting in the Greenbrier, White Sulphur Springs, West Virginia, May 31 to June 5. Because of the nature of the papers, none but American and Allied citizens will be permitted to register and attend the sessions, John A. C. Warner, secretary and general manager of the Society, said.

The meeting has been telescoped into five and a half days, with morning, afternoon, and evening sessions. Approximately 50 technical committee meetings will be sandwiched in between these formal sessions.

All organized golf, tennis, and other sports tournaments, which in the past have been a popular feature of the SAE Summer meetings, have been canceled. Engineering sessions are expected to run far into the nights.

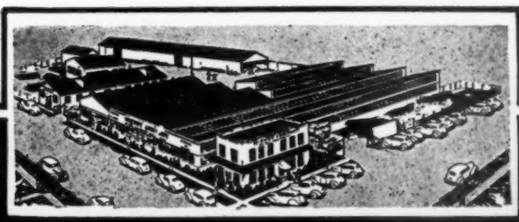
Design and manufacturing problems involved in producing arms with the vast technical facilities of the whole automotive industry, will highlight the meeting.

The meeting will be the occasion for consolidating technical progress made by the two-score SAE committees that are actively engaged in working on specialized war problems assigned to them by Army ground and air branches, by technical divisions of the War Production Board, the Office of Defense Transportation, and other military and governmental agencies.

EASILY READ AT NIGHT, TOO

Billboard figures and large scale divisions on a clear, steady dial make the Abercrombie Pressure Gauge just as easy to read at night under artificial light. No chance for error... no need for strained eyes to make out miniature figures. It's easy to see why so many drillers prefer this accurate gauge for oil, water, mud or gas pressure lines.

Abercrombie Pump Co., Gulf Bldg., Houston, Texas



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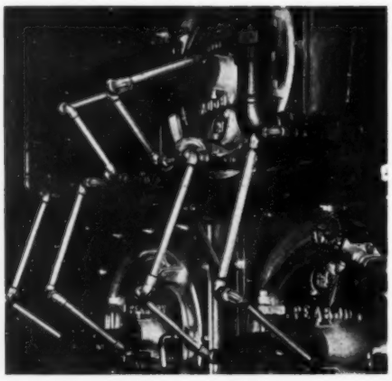


CHIKSAN for FLEXIBLE CONNECTIONS to BURNERS

Illustration above shows a typical installation of CHIKSAN Ball-Bearing Swing Joints to provide required flexibility in fuel lines to the burners in the boiler room of a large independent refiner. Just one of the many refinery applications in which thousands of CHIKSAN Swing Joints are used.

Style 60 Chiksan High Temperature Swing Joint for temperatures to 700° F. and 500 lbs. pressure. One of over 500 different Types, Styles and Sizes.

Nothing to Tighten or Adjust

Full 360° rotation in 1, 2 and 3 planes, turning on double rows of steel balls which carry all radial and thrust loads and maintain alignment of moving parts. Unobstructed inside diameter permits full flow of liquids, vapors or gases.

For High and Low Pressures and High Temperatures

Made in suitable materials for pressures from 300 to 3,000 pounds and temperatures to 700° F. Sizes from ⅜" to 12". Larger sizes to order.

CHIKSAN TOOL COMPANY

CHIKSAN

BALL BEARING SWING JOINTS for ALL PURPOSES

BREA, CALIFORNIA

ALL-STEEL ROTARY HOSE
CIRCULATING HEADS · MUD GUNS

Exploration Bodies to Meet Jointly

A joint annual meeting of The American Association of Petroleum Geologists, The Society of Economic Paleontologists and Mineralogists, and The Society of Exploration Geophysicists will be held in Denver, Colorado, at the Cosmopolitan Hotel on April 22, 23, and 24, 1942. These societies, which represent three branches of the exploration activities of the petroleum industry, are uniting their efforts to find new reserves of oil necessary to the needs of industry and the war effort. The Rocky Mountain Association of Petroleum Geologists is serving as host for the meetings.

Ralph L. Carr, Governor of Colorado, will give the address of welcome at the opening meeting on Wednesday morning. Other speakers will include H. E. Christensen, president of the Rocky Mountain Association of Petroleum Geologists; Edgar W. Owen, president of the American Association of Petroleum Geologists; H. B. Peacock, president of the Society of Exploration Geophysicists; H. V. Howe, president of the Society of Economic Paleontologists and Mineralogists; Wallace Pratt, director and member of the executive committee, Standard Oil Company (New Jersey); Carey Croneis of the Walker Museum, University of Chicago, and E. L. DeGolyer, director of Conservation, Office of the Petroleum Coördinator.

On Wednesday evening, a limited group composed of the national service committee, the chief geologists and geophysicists of the large oil companies, or their delegates, and the district representatives of the A.A.P.G., will meet to discuss the emergency problems of personnel.

The last two days of the convention will be devoted to the presentation of technical papers. Problems of geology to be discussed at these meetings will include "Origin of Oil," "Migration and Accumulation of Oil," "Oil Field Waters," "Sedimentation," and "Relation of Oil Analyses to Stratigraphy." The research committee conference, headed by A. I. Levorsen, Tulsa, Oklahoma, chairman, will be held on Tuesday evening to consider the subject of "Oil-Discovery Methods."

Committee chairmen. Seated (left to right): C. E. Erdmann, vice-president, Rocky Mountain Association of Petroleum Geologists; H. E. Christensen, president, Rocky Mountain Association of Petroleum Geologists; C. E. Dobbin, general chairman; F. M. Van Tuyl, Eastern Slope trips, and A. E. Brainerd, technical program. Standing (left to right): W. A. Waldschmidt, publicity; C. A. Heiland, Society of Exploration Geophysicists; C. M. Rath, registration; W. O. Thompson, educational exhibits; C. S. Lavington, hotels; H. W. Osborne, entertainment, and J. H. Johnson, Society of Economic Paleontologists and Mineralogists

New Officers Eastern District of A.P.I.

At the Spring Meeting of the A.P.I. Eastern District Division of Production, held in Pittsburgh, Pennsylvania, April 9 and 10, the following officers were elected:

M. G. Gulley, chairman, Gulf Oil Corporation, Pittsburgh, Pennsylvania; R. B. Anderson, vice-chairman, Columbian Carbon Company, Charleston, West Virginia; V. F. Bowyer, vice-chairman, The Peoples Natural Gas Company, Pittsburgh; R. E. Damp, vice-chairman, The Carter Oil Company, Mattoon, Illinois; W. E. Ferguson, vice-chairman, The Ohio Fuel Gas Company, Columbus, Ohio; C. C. Irby, vice-chairman, Turner Petroleum Corporation, Mt. Pleasant, Michigan, and J. V. Goodman, secretary-treasurer, Equitable Gas Company, Pittsburgh.

Wellman New B and W Distributor

W. J. WELLMAN

B and W, Inc., of Houston, Texas, have appointed W. J. Wellman, 405 West First Street, Odessa, Texas, as their distributor for wall-cleaning guides in the West Texas and New Mexico area.

In addition to carrying complete stocks of this equipment, Wellman will provide service, without additional charge, to assist operators in establishing proper guide placement when installing on the rig, and throughout the cementing operation, it is stated.

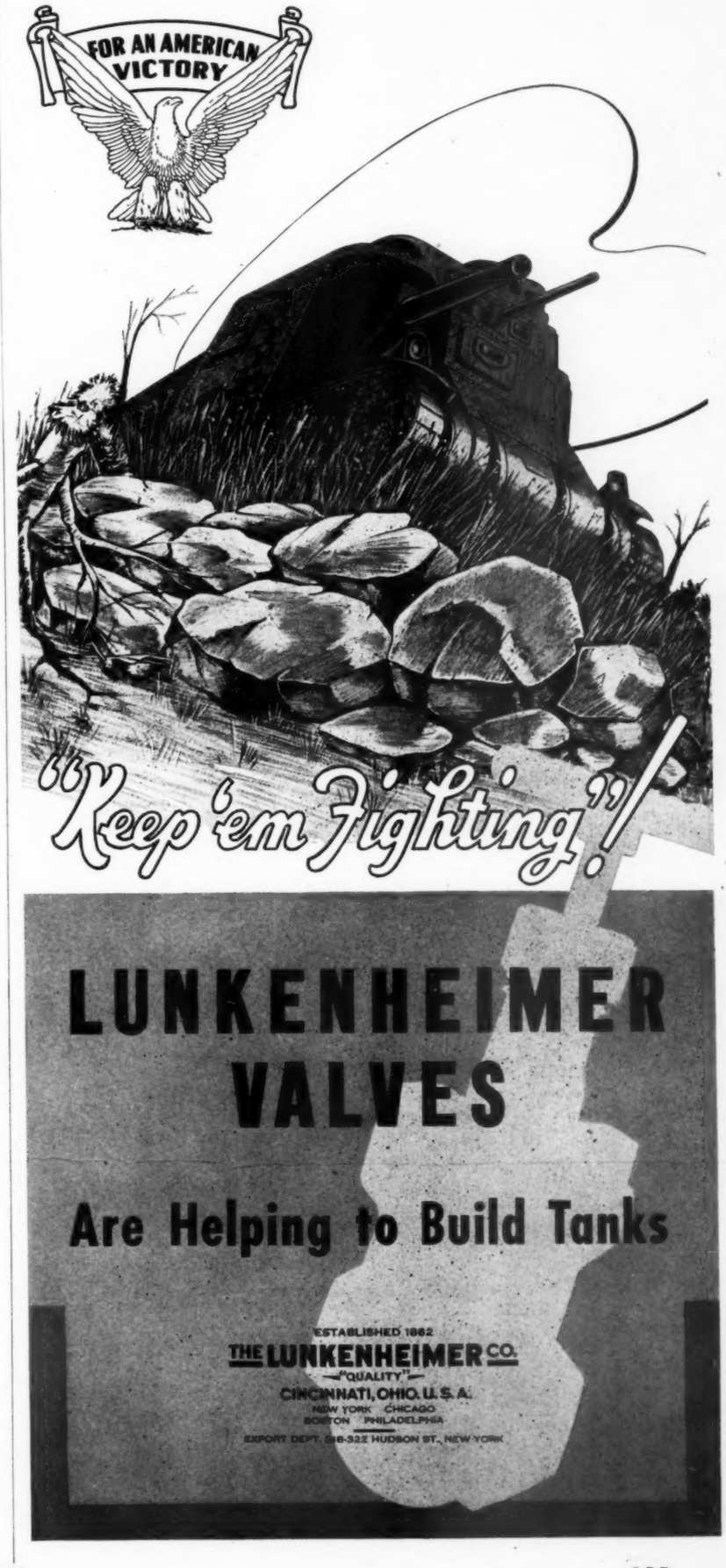
C. L. Brockschmidt With War Production Board

C. L. Brockschmidt, combustion engineer with the Mississippi River Fuel Corporation, and for the last three years in charge of that company's corrosion program, has been appointed a

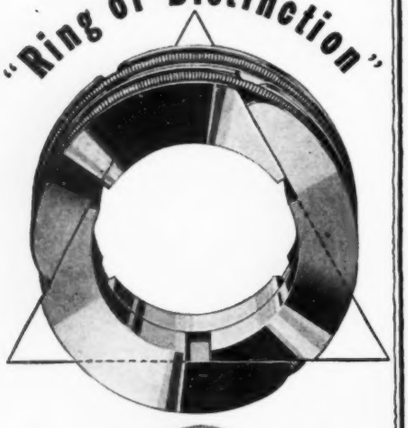
C. L. BROCKSCHMIDT

special consultant on gas problems in the Power Division of the War Production Board. He is making his headquarters in Washington, D. C., and will have as his particular work the administration of Order L-31, which limits the distribution of natural gas in major industrial areas.

Brockschmidt graduated from Texas A. and M. College in 1926 with a bachelor of science degree in chemical engineering. From 1927 to 1931 he was an industrial gas engineer with the Lone Star Gas Company, and since that time until his recent appointment had been with the Mississippi River Fuel Corporation.



"Ring of Distinction"



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Here are typical excerpts from experience among thousands of satisfied users.

"The France Packing in a .....pumping engine has been in service 32 years and is still working satisfactorily."

"France Metal Packing used on our engines for 27 years and is still working under a pressure of 170 lbs. superheated. .....will in all probability outlive us."

"France Packing has always been tight. ..... Same compressor packed with ordinary packing required a large amount of labor to keep the stuffing boxes tight."

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44-page Catalog of useful and valuable information. Write for your free copy of Catalog M-3, with facts on

- Packing Designs for Any Service
- Installation Procedure
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Request France Engineers to analyze your packing requirements. There is a representative close at hand.

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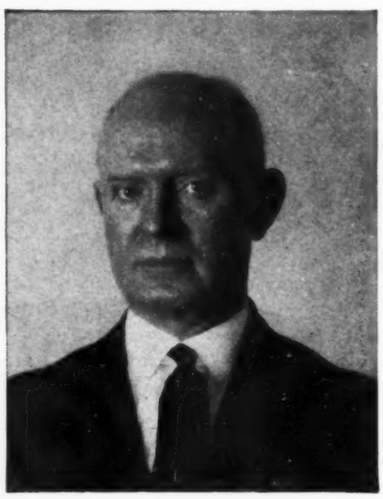
FORT WORTH, TEXAS

Original FRANCE METAL PACKING

Death Calls E. T. Fishwick

Edward T. Fishwick, vice-president and director of the Worthington Pump and Machinery Corporation, died March 15 at his home in Glen Ridge, New Jersey.

Fishwick had been with the Worthington organization for 49 years, having begun work with the corporation at its Cincinnati Works. He was senior vice-president of the corporation. He was also president and director of the Worthington-Gamon Meter Company of Newark, New Jersey; a director of the Glen Ridge Trust Company; a director of the New Jersey State Chamber of Commerce, and was formerly head of the Diesel Engine Manufacturers Association.



EDWARD T. FISHWICK

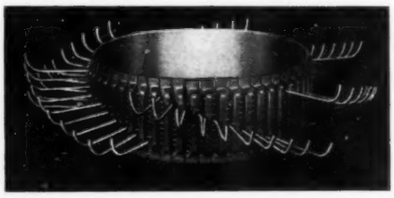
A. W. Herrington Technical Adviser on U. S. Mission

The current American diplomatic and economic mission to India, headed by Col. Louis Johnson, faces the gigantic task of organizing the potential producing power of India to supply arms and munitions to the armies of China and the other allied forces in the Orient.

Col. Johnson, who was recently appointed the first U. S. Minister to India, has selected A. W. Herrington, head of The Marmon-Herrington Company, Inc., Indianapolis, Indiana, as his technical adviser and assistant, according to current news releases from Washington.

"Herrington's intimate knowledge of conditions in the Near and Far East, where he has spent perhaps a third of his time during the last ten years, plus his acknowledged leadership in the design and production of All-Wheel-Drive military trucks, track-laying artillery tractors, combat tanks and other vehicles of war, makes him a logical choice for this important mission," said a high ranking government official.

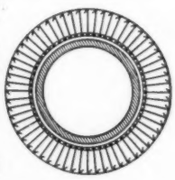
Center YOUR CASING with B and W, Inc. WALL CLEANING GUIDES



AVERAGE THICKNESS of the cement sheath around the casing in an oil well is only 1½", but even this is theoretical, because a very slight angle of inclination throws the casing off center and may reduce cement to ½"—or less—perhaps to zero!

LIKE A PENDULUM, an oil well casing is hard to sway near the top, but progressively EASIER to sway further down the hole. Thus a minor directional change near bottom will cause casing to lie against one side of the hole. **RESULT:** Faulty cementing.

THE ANSWER: The low unit cost of B and W Wall Cleaning Guides permits usage of a series of Guides carrying multiple spring wires, placed at intervals, to center the casing throughout the ENTIRE section.



IN ADDITION — and equally important — B and W Guides remove the mud filter cake from the wall of the hole just before and as the cement is placed, assuring **CONTACT** between the cement and formation.

WRITE FOR BULLETIN 102

BRUCE BARKIS — B and W, Inc. — KENNETH WRIGHT
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Gulf Coast & Foreign Distributors of
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Los Angeles Nomads Carry On During Blackout

The flying experiences of an American pilot in China were presented to the Los Angeles Chapter of Nomads during a blackout that began in the middle of the regular monthly dinner meeting held in Los Angeles, April 8. The first speaker of the evening had just begun his address when the blackout siren sounded but candles were soon placed on the tables to provide sufficient light for enjoyment of the talks.

Immediately after the dinner Fred Ripley distributed Nomad shingles to members recently taken into the Chapter. Elmer Decker then conducted induction ceremonies for two new members, Paul Daniels and Tom Bannon. National Regent Ted Sutter presented the retiring president, Ernie Fowks, with a gavel in token of esteem for his work during the previous year.

Three men of the Latin American consular service were introduced by Bart Gillespie. They were Hon. Fernando Flores, Vice-Consul to the Consul General of the Eleven Western States for Costa Rica; Hon. Duke N. Banks, Consul for Bolivia, and Hon. Carlos Grimm, Vice-Consul for Mexico. Sr. Grimm then gave a talk on the good relations existing between Mexico and the United States.

Elmer Decker was called on to tell of his recent trip through the middle west, to Washington, up to Toronto, and back through the Rocky Mountain States to California.

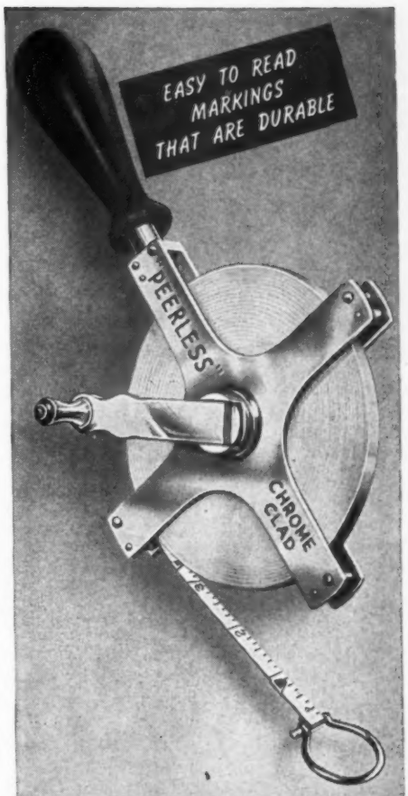
The main speaker of the evening was Capt. Royal Leonard who was pilot for Chiang Kai-Shek.

Preceding the speeches, President Bill Bettis announced the following standing committees of the Los Angeles Chapter for the coming year: Entertainment Committee: Roland Smith, chairman, Tom Murphy, and J. V. Robinson. Membership Committee: Fred Ripley, chairman, Bert Stone, and George Colley, Jr. Ways and Means Committee: Abe Haglund, chairman, Charles Tut Lee, and Harry Morehouse. Ritual and Induction Committee: Earl Rees, chairman, Elmer Decker, induction master, Ted Sutter, and Frosty Martin. The Reception Committee will be the same as the Induction Committee plus two members selected for each meeting. Publicity Committee: Wallace Sawdon, chairman, Fred Ripley, editor of *Flying Carpet*.

Among the foreign guests in attendance at the meeting were A. Templaar-Lietz, formerly with the C.P.C. in Venezuela; Reiner H. VanNierop and D. A. Kwakernaat of the V.O.C., Venezuela; Temple Waite of the U.B.O.T., Trinidad; H. A. Baker, J. S. Dykes, and C. D. Hendershott recently with N.P.P.M. in Java and Sumatra; Jess Rector from Canada; Bill Thornberry of Ecuador Oilfields, Ltd., Ecuador, and Walter Shakelton from Canada.

Officers Tulsa Chapter Nomads

Officers for 1942, recently elected for the Tulsa Chapter of Nomads are (left to right): Paul Fitzgerald, Dowell Incorporated, vice-president; W. G. Green, Engineering Laboratories, Inc., regent; C. O. Willson, *Oil and Gas Journal*, president; H. M. Cosgrove, Purchasing Agents Association of Tulsa, secretary-treasurer, and Fred E. Cooper, Fred E. Cooper Company, regent.



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If you're interested in a steel tape for tank strapping, be sure to see the Lufkin "Peerless" Chrome Clad. You'll find it perfect for the job. Jet black markings are easy to read against the satin chrome surface that won't rust, crack, chip or peel. Frame is extra sturdy and winding mechanism extra smooth. See your supply house and write for free general Catalog.

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NATIONWIDE SALES AND STOCKS

P.I.E.A.-P.E.S.A. Meet in Shreveport

The Annual Convention of the Petroleum Industry Electrical Association and the Petroleum Electric Supply Association will be held in Shreveport, Louisiana, April 22 and 23 at the Washington-Youree Hotel. The program of the P.I.E.A. has been announced as follows:

WEDNESDAY, APRIL 22

9:30 A. M.—Crystal Ball Room

Welcome to Shreveport
L. M. Moffitt, President, Shreveport Chamber of Commerce

Response
C. O. Diller, President, Petroleum Industry Electrical Association

Introductions

Message from P.E.S.A.
Geo. T. Brundrett, President

Announcements

Report of the President

Roll Call of Members

Reading of minutes of 1941 session

Report of committees

Discussions

Meeting Cathodic Section
(Meeting place to be announced)
Committee reports:
Technological
Donald H. Bond, Chairman
Intercompany Procedure
E. A. Koenig, Chairman
Nominating
R. A. Brannon, Chairman

1:30 P. M.—Crystal Ball Room
F. W. Littell, Chairman

"Coaxial Cable Development," by K. C. Black, Staff Member, Bell Telephone Laboratories New York, New York

Discussion

Symposium
(For P.I.E.A. members only)
Supervised discussion on communication problems of today

Election of officers

Meeting Cathodic Section
(Meeting place to be announced)
1:30 P. M.

"When and Where to Use Insulating Flanges," by Wm. E. Huddleston, Cities Service Gas Company

"Maintenance Requirements for Adequate Operation of Cathodic Protection Equipment," by Donald H. Bond, The Texas Pipe Line Company

"Cathodic Protection of Tank Farms," by R. A. Brannon, Humble Pipe Line Company

THURSDAY, APRIL 23

9:00 A. M.—Crystal Ball Room
H. C. Gear, Chairman
G. R. Olson, Secretary

"The Economic Justification of Ca-

SHELL-OUT to OUT SHELL the Axis!

A battle cry for VICTORY! Not a command, for Americans need no command to do their patriotic duty—not a demand, for America asks not demands of her people. "SHELL OUT TO OUT SHELL THE AXIS" is a battle cry worthy of repetition ... of passing along to others ... a reminder to keep on buying more and more Defense Bonds and Stamps. Yours for VICTORY!

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Hotel Thomas Jefferson.....Birmingham

DISTRICT OF COLUMBIA
Hotel Washington.....Washington

ILLINOIS
Hotel Faust.....Rockford

LOUISIANA
Jung Hotel.....New Orleans
Hotel DeSoto.....New Orleans

MISSISSIPPI
Hotel Lamar.....Meridian

NEBRASKA
Hotel Paxton.....Omaha

NEW MEXICO
Hotel Clovis.....Clovis

OKLAHOMA
Oklahoma Biltmore.....Oklahoma City
Hotel Aldridge.....Wewoka

SOUTH CAROLINA
Hotel Wade Hampton.....Columbia

TEXAS
Hotel Alice.....Alice
Hotel Stephen F. Austin.....Austin
Hotel Settles.....Big Spring
Hotel Brownwood.....Brownwood
Hotel Southern.....Brownwood
Hotel Laguna.....Cisco
Hotel Cortez.....El Paso
Hotel Texas.....Fort Worth
Hotel Buccaneer.....Galveston
Hotel Galvez.....Galveston
Hotel Jean LaFitte.....Galveston
Coronado Courts.....Galveston
Jack Tar Court.....Galveston
Miramar Court.....Galveston
Hotel Cavalier.....Galveston
Hotel Plaza.....Laredo
Hotel Lubbock.....Lubbock
Hotel Falls.....Marlin
Hotel Cactus.....San Angelo
Angeles Courts.....San Antonio

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Mountain Lake Hotel.....Mountain Lake

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thodic Protection," by L. F. Scherer, The Texas Pipe Line Company
"Cathodic Protection of Distribution Systems," by Ray M. Wainwright, Montana-Dakota Utilities Company
"Cathodic Protection and Corrosion From Management's Viewpoint," by N. C. McGowen, President, United Gas Pipe Line Company

1:30 P. M.—Crystal Ball Room
D. H. Levy, Chairman

"The Partnership of Light and Darkness in Military Defense," by Samuel G. Hibben, Director of Applied Lighting, Westinghouse Electric and Manufacturing Company, Bloomfield, New Jersey
Discussion
"Conserving Our Greatest Asset," by C. L. Hightower, Safety Director, United Gas Pipe Line Company
For P.I.E.A. members only:
Unfinished business
Installation of officers
New business
Discussions

THURSDAY EVENING
7:00 o'Clock—Crystal Ball Room
Annual Banquet

"America's Challenge," address by J. Handly Wright, Executive Vice-President, Associated Industries of Alabama, Birmingham, Alabama

Cathodic Section Only
FRIDAY, APRIL 24
9:30 A. M.
(Meeting place to be announced)

"Current Density Determinations on Refinery Piping," by Derk Holstein, Shell Refinery
"Corrosion Problems on Refinery Equipment," by V. L. Nealy, The Texas Company
"Recent Progress in Practical Applications of Cathodic Protection," by G. R. Olson, United Gas Pipe Line Company

1:30 P. M.
Installation of new officers
Roundtable discussions

The Petroleum Electric Supply Association will hold its meetings as follows:

TUESDAY APRIL 21
8:00 P. M.—Suite 1424
Directors' meeting

WEDNESDAY, APRIL 22
10:30 A. M.
General Meeting
Roll call
Report of president
Report of secretary-treasurer
Reports of committees
Appointment of nominating committee
General business

THURSDAY, APRIL 23
10:30 A. M.
General Meeting
Reports of committees
Election and installation of officers
Unfinished business

Civil-Service Examinations Reannounced for Scientists

In an effort to meet the increasing need for these scientifically trained men and women in the Federal Government, the Civil Service Commission has reannounced, with modified requirements, its examinations for physicist, chemical engineer, and explosives chemist. The salaries in each of these three fields range from $2600 to $5600 a year. For all, appropriate college study and experience are required.

In the field of physics, there is great demand for physicists well qualified in stress analysis, ballistics, elasticity, vibration studies, vacuum-tube circuits, and short radio waves. Provision is made in the new announcement for accepting applications for the assistant grade positions ($2600 a year) from applicants who wish to qualify on college teaching unaccompanied by research.

In chemical engineering the commission has adequate employment lists in some branches; however, there is a shortage of qualified people in plant layout, equipment design, market analysis, chemical economics, heavy chemicals, plastics, rubber, agricultural by-products, and strategic minerals. Applicants may now substitute college teaching in chemical engineering or chemistry for part of the prescribed experience.

In the new physicist and chemical engineer examinations, the "recency" requirements relative to experience have been modified. Although preference in certification will be given to those eligibles who acquired at least one year of their required education or experience within the 10 years immediately preceding the filing of their applications, those whose qualifying education or experience was gained previous to that 10-year period may be certified and appointed.

There is no "recency" clause in the new examination announced for explosives chemist; applicants' experience may have been gained at any time. Chemists are needed who have had experience in the handling, production, and investigative work in explosives chemistry, but any kind of experience wherein laboratory techniques or plant processes are employed that are very similar to those used in explosives will be considered qualifying experience.

In all these examinations the age limit has been raised to 60 years, for regular probational appointment. Provision is also made for the waiver of age and physical requirements for temporary positions connected with the National Defense program.

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TOTAL WEIGHT—HUNDREDS OF POUNDS

Solve Boiler Scale
THE MODERN
SAND-BANUM WAY

16 OUNCE CAN
ALL ACTIVE INGREDIENTS

"The Entirely Different Boiler and Engine Treatment"

Sand-Banum Safely and Economically removes old and prevents new boiler scale and corrosion. One application each week does it. . . Write for data.

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Look for the Arm and Hammer
ARMSTRONG BROS.
CHAIN TONGS

You can show lower tool cost if you standardize on ARMSTRONG BROS. CHAIN TONGS, for they have no "weakest link".

Jaws are drop forged from special steel, are hardened, tempered and tested for wearing qualities. Chains are proof-tested to two-thirds catalog strength (3,600 to 40,000 lbs.). Handles, shackles, bolts . . . tested steels, tested designs . . . Proven strength that will not fail, that will always stand up and give long, dependable service.

Write for Catalog C-39 showing improved Pipe Tools

"The Tool Holder People"
ARMSTRONG BROS. TOOL CO.
331 N. Francisco Ave., Chicago, U.S.A.
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Removes Paraffin from Rods

Double-duty Sucker Rod Protector. Equipped with double seal for wiping rods plus a lower cone-shaped stripper for removing paraffin.

Equipped with two side outlets for discharge of excessive paraffin. The latter can't drop back into the well.

Your Rods are automatically stripped. The body of this compact Wiper is made of cast steel and has a safety latch for locking the rods. Universal Type. Rubber refills available. See Composite Catalog.

PATTERSON-BALLAGH SUCKER ROD WIPER

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Use DURA HOOKS

Sturdy ALL STEEL Packing Pullers

A dependable hand tool designed for severe service. A time saver . . . a labor saver. Has a flexible steel cable shaft with a tempered tool-steel corkscrew bit. Made in 6 sizes. Guaranteed.

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KALAMAZOO MICHIGAN

TRADE LITERATURE

What to Write For

B AND W WALL CLEANING guides are described in Bulletin 102, which will be sent on request. Address B and W, Inc., 3545 Cedar Avenue, Long Beach, California.

COMPLETE INFORMATION and assistance on pump problems is offered by Fluid Packed Pump Company, Box 64, Los Nietos, California, in their new descriptive catalog. Readers are urged to write for their copy, which will be sent without obligation.

WALL-COLMONOY CORPORATION, Buhl Building, Detroit, Michigan, will mail without obligation their catalog on "Colmonoy" coating for equipment subject to abrasive wear in the oil industry.

ADDRESS BANTAM BEARINGS CORPORATION, South Bend, Indiana, for Bulletin P-104 on the Bantam Quill Bearing. The bulletin will be sent on request without obligation.

"THE PIPE OF PROGRESS", a 44-page booklet released by Republic Steel Corporation, Cleveland, Ohio, explains that company's exclusive fabricating processes and the advantages they produce in Republic Electric Weld Products. The booklet will be sent on request.

D. W. HAERING AND COMPANY, INC., 205 West Wacker Drive, Chicago, Illinois, offer four interesting booklets that will be sent without obligation as follows: "Organic Methods of Scale and Corrosion Control", "Cooling Waters", "H-O-H Lighthouse Reprints", "The Solution of Your Proportioning Problems", and other booklets on water treatment for power plants, refrigeration plants, petroleum industries, public buildings, transportation industries, and process industries.

THE FRANCE PACKING COMPANY, Tacony, Philadelphia, Pennsylvania, will send on request their 44-page catalog of useful information on vanadium metal packing.

A DESCRIPTIVE BULLETIN explaining "Dura Hooks", a hand tool designed for severe service in pulling packing, will be sent on request. Address Durametallic Corporation, Kalamazoo, Michigan.

TWO BOOKS, "MOLYBDENUM IN STEEL" and" Molybdenum in Cast Iron" just released by Climax Molybdenum Company, 500 Fifth Avenue, New York, New York, will gladly be sent free on request.

"HOW TO ENCOURAGE EYE PROTECTION IN YOUR PLANT" is the title of a new folder being released by E. D. Bullard Company, 275 Eighth Street, San Francisco, California.

CATALOG C-39, released without obligation on request, shows improved pipe tools. Address Armstrong Bros. Tool Company, 331 North Francisco Avenue, Chicago, Illinois.

USERS OF AIRCO OXY-ACETYLENE MACHINES for cutting steel are urged to request the 8-page bulletin on Airco "45". This bulletin will be sent without obligation by Air Reduction Company, 60 East 42nd Street, New York, New York.

"BULLETIN A" gives the interesting story of the portable laboratories and services available throughout the United States by Core Laboratories, Inc., Santa Fe Building, Dallas, Texas.

THE COMPLETE STORY of the manufacture of ball bearings is told in a bulletin prepared by SKF Industries, Inc., Front Street and Erie Avenue, Philadelphia, Pennsylvania, entitled "How Balls Are Made Round". This interesting bulletin will be sent on request without obligation.

A NEW ILLUSTRATED 6-PAGE BOOKLET, No. 1928, describing the new model HC-70 truck-mounted crane, a highly mobile and versatile machine, is being released by Link-Belt Speeder Corporation, 301 West Pershing Road, Chicago, Illinois.

A COMPLETELY NEW BULLETIN on Olympic packers and liner hangers has been announced by Lane-Wells Company containing descriptions of nine types of packers and three types of liner hangers for oil and gas applications. Copies of the Lane-Wells Olympic Packer Bulletin are available from Lane-Wells Company, 5610 South Soto Street, Los Angeles, California.

BOILER FEED WATER LEVEL CONTROLLERS, designed on the cantilever principle, are featured in a new bulletin just issued by J. A. Campbell Company, 651 Wardlow Road, Long Beach, California.

THE FEATURES OF DETACHABLE JACKBITS are described in a 2-color, 24-page bulletin announced by Ingersoll-Rand Company, 11 Broadway, New York, New York. The new bulletin is entitled "How Jackbits Reduce Rock Drilling Costs", and contains more than 50 illustrations of jackbits for different kinds of work and various cost data. Free copies of the booklet, Form 2780, may be obtained on request.

A PAMPHLET just off the press describes a new small engine, the International Type LB. This new engine is made in sizes to develop 1½-2½ hp. and from 3-5 hp. and makes use of hopper-cooling and radiator-cooling. For your copy address International Harvester Company, Inc., 180 North Michigan Avenue, Chicago, Illinois.

A NEW BULLETIN has just been issued presenting the complete line of Foxboro Potentiometer Temperature Indicators and Indicating Resistance Thermometers. The instruments illustrated and described include single-point and multiple-point models, models equipped with selective key-switches for as many as 82 contact points, as well as the portable models. Copies of the bulletin, No. A-305, will be sent on request.

H. D. Aggers, Sr., Dead

Harry D. Aggers, Sr., father of Harry D. Aggers of the Union Oil Company of California, Bakersfield, died March 23 at Long Beach, California, after an emergency operation.

He was widely known in all of the oil-producing areas, having been born in Pennsylvania, the son of one of the original old-time oil men. He came to California during the days of Coalinga and Kern River and then went to the Mid-Continent.

His most recent connections with the oil industry were with L. H. Wentz, Ponca City, Oklahoma, Eastern Oil Company, Tulsa, Oklahoma, Midco Oil Company, Tulsa, U. S. Department of Interior, Pawhuska, Oklahoma, and U. S. Bureau of Mines, Drumright, Oklahoma. He had lived in California the last six years, his home being in South Gate at the time of his death.

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In times like these, getting FULL use out of present equipment is one of your BIG wartime jobs. This means you must maintain that equipment in good operating condition... get it to serve you and the Nation harder and longer!

That is why you should investigate this improved, time-saving Oakite method for cleaning absorption towers. Recommended solution of heavy-duty Oakite cleaning material, circulated through tower, loosens and removes most types of sludge and gummy carbon deposits. Method saves considerable time, effort... helps restore towers to near original capacity. Write today for complete details!

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OAKITE Specialized **CLEANING**

How MUCH do you know about

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You know about JENSEN JACKS, of course. But how much do you know? How dependable is your information?

Some of our best customers could kick themselves because they failed to investigate sooner. They thought that a JENSEN JACK was just another pumping unit!

Don't make the same mistake! Regardless of the equipment you are now using, the economy and efficiency of JENSEN UNITS deserve your careful consideration.

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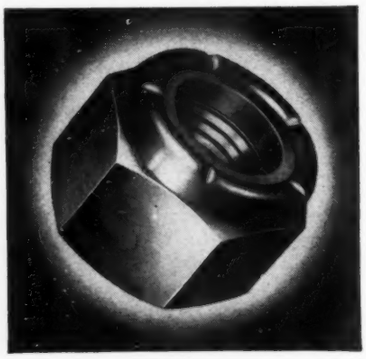
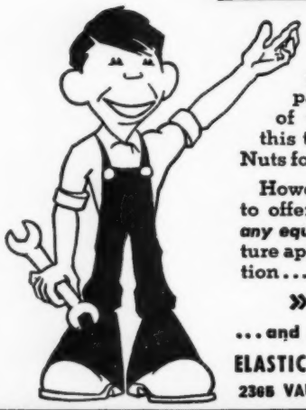
Now is the time to TEST THIS SELF-LOCKING NUT ON YOUR EQUIPMENT...





WITH our entire production going into airplanes, tanks, gun mounts, patrol boats, and other tools of war, it is not possible at this time to furnish Elastic Stop Nuts for all petroleum equipment.

However, we *are* in a position to offer sample nuts *for testing on any equipment*... with a view to future application. No cost or obligation... *Just specify your requirements.*

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Elastic Stop SELF-LOCKING NUTS

Book Reviews

Oil in the Earth, by Wallace E. Pratt, published by University of Kansas Press, The University of Kansas, Department of Geology, Lawrence, Kansas. 105 pp. Price $1.00.

An informative discussion of how and where oil occurs, how it is discovered, and how possession of oil resources affects world affairs, the book is written in clear non-technical style and gives a concise and authoritative treatment of a most important subject. Many years of practical experience in this and other countries as geologist and executive officer for large oil companies well qualify the author to discuss this all-important economic mineral resource, oil. The analysis contained in the book of who finds oil and whose oil it is are especially pertinent and of interest now in view of the present-day world affairs.

●

Physics for Engineers, by Sir Ambrose Fleming, published by the Chemical Publishing Company, Inc., Brooklyn, New York. 232 pp. Price $3.00.

"A masterly survey of present-day knowledge in the realm of physics written with special reference to the requirements of engineers." The book contains 89 diagrams and photographs as illustrations. The text of the book deals with fundamental physical units, matter and electricity, forms of energy and equivalents, energy transformations, fundamental principles of electrostatics and electro-magnetism, alternating electric currents and supersonic vibrations, atomic transformations, production of electric currents, systems of electric measurement, electric measuring instruments, thermionic and photo-electric emission, technical applications of electronic emission, radiation and the quantum theory, electron optics and wave theory of matter, sound, music, and telephony.

●

Possible Future Oil Provinces of the United States and Canada, edited by A. I. Levorsen, published by The American Association of Petroleum Geologists, Box 979, Tulsa, Oklahoma. 154 pp. Price $1.50.

This book constitutes a symposium conducted by the research committee of the American Association of Petroleum Geologists, A. I. Levorsen, chairman, of papers read before the association at the 26th annual meeting at Houston, Texas, April 1, 1941, and published in the association's bulletin in August, 1941. Purpose of the symposium is to present an over-all picture of the undiscovered oil resources of North America, north of the Rio Grande. A map and a section of geology, stratigraphy, and structure illustrate each province description. In addition the book contains 154 pages and 83 line drawings.

●

Thermochemical Calculations, by Ralph R. Wenner, published by McGraw-Hill Book Company, 330 West 42nd Street, New York, New York. 384 pp. Price $4.00.

"In this important new book the author meets the need for a volume on applied thermodynamics which presents a comprehensive introduction to the modern principles, methods, and data available for the solution of a wide variety of practical laboratory and technological problems."

Features of the book are a concise presentation, chiefly by means of solved problems, of the fundamental principles of thermodynamics of primary interest to the chemist and chemical engineer; a presentation of the practical contributions of the theoretical physicist to the field of thermodynamics; a presentation of various semi-empirical methods for the estimation of thermodynamic functions of value in solving technical problems.

Association of Well Head Equipment Manufacturers Meets

At the regular monthly meeting of the Association of Well Head Equipment Manufacturers held in Houston, Texas, at the Houston Club, March 17, the usual business routine of the association was accomplished, which included committee reports on objectives, in conformance with instructions of the membership at the last regular meeting of the association.

In line with the government's program of conservation of materials, the committee report on Objective No. 2 (Standardization) was of major importance. This report carried recommendations that immediate steps be taken toward the simplification of Christmas trees and other parts comprising wellhead equipment, thus assisting in the government program as it is outlined. This recommendation was unanimously approved by the membership and the chairman of this committee, C. L. Cron, was instructed to appoint a sub-committee to study this subject carefully and submit its report to the parent committee for further action, at the earliest possible date.

Also receiving the approval of the membership were the booklets just completed, in which the work of committees and action by the membership were outlined. These booklets outline the "Terms and Definitions" applying to wellhead equipment and the "Code of Recommended Practices on the Pressure-Testing Certification of Well Head Equipment."

In connection with the activities of the association these booklets are now available for distribution and will be mailed upon request, by Association of Well Head Equipment Manufacturers, 508 Niels Esperson Building, Houston, Texas.

Sam E. Rees Passes Away

Samuel E. Rees, secretary-treasurer, purchasing agent, and credit manager of Baker Oil Tools, Inc., Los Angeles, California, passed away on March 26 at 2:00 p. m. He had reported for work and took sick about 10:30 a. m. His funeral was held at the Wheat Hålverson Mortuary in Huntington Park and interment was at Inglewood Park Mausoleum April 2.

Rees was born near Kerrville, Texas, October 4, 1892. He received his early education in Kerrville and later attended Texas A. and M. College. He taught school in Texas for a time prior to going to California.

In California he located in Coalinga and represented the American Railway Express Company there for a short time, later working for A. P. May as a clerk and bookkeeper in his general merchandising store. He subsequently went into business for himself, handling hay, grain, wood, and coal. He was engaged in this business for several years during the days prior to the automobile when horses were the chief mode of transportation. After the advent of the automobile, Rees sold out his business and moved to a farm near Coalinga where he remained for a number of years before becoming associated with the Baker Oil Tools, Inc., at their Huntington Park office on February 25, 1927.

Link-Belt Elects New Directors

At the annual meeting of stockholders of Link-Belt Company, March 31, in the company's executive office, 307 North Michigan Avenue, Chicago, Illinois, Alfred Kauffmann, B. A. Gayman, and J. Reece Lewis were re-elected directors for the full term of three years. Two new directors also were elected: Clarence Tolan, Jr., president of Dodge Steel Company, Philadelphia, for the full term of three years, to succeed Wellington Wells; and William C. Carter, executive vice-president, Link-Belt Company, Chicago, for a term of two years, to succeed George L. Morehead.

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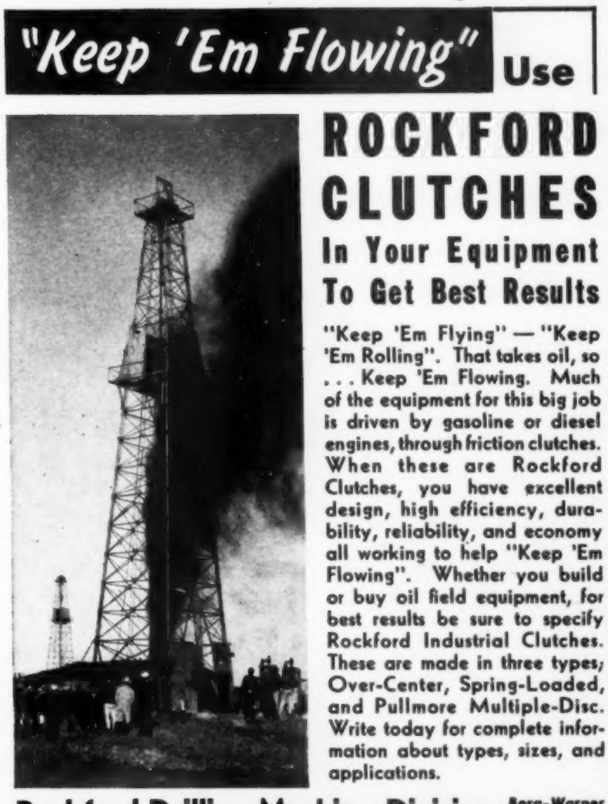
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Program Includes Synthetic Rubber for Civilian Use

As a result of the Petroleum Industry War Council's resolution regarding construction and expansion of a synthetic rubber program designed to supply a minimum of 300,000 tons of synthetic rubber for civilian use, over and above the Government's present program of 700,000 tons, W. R. Boyd, Jr., chairman of the Council, announced the appointment of a committee to tackle this difficult problem.

To speed action, the committee is authorized to make an immediate study of the problem, especially that of butyl rubber, and it is directed by the chairman to develop and prosecute without further action by the Council, a program designed to obtain synthetic rubber for essential civilian uses.

The committee named by Chairman Boyd, with the approval of the Deputy Petroleum Coördinator, is composed of W. S. S. Rodgers, president of The Texas Company, chairman, and the general chairmen of each of the country's five regional districts as established by Petroleum Coördinator Harold L. Ickes. The district general chairmen are, John A. Brown, president of Socony-Vacuum Oil Company, New York City; Frank Phillips, chairman of the board of directors, Phillips Petroleum Company, Bartlesville, Oklahoma; Chas. F. Roeser, president, Roeser and Pendleton, Fort Worth, Texas; Wm. H. Ferguson, executive vice-president, Continental Oil Company, Denver, Colorado, and Wm. F. Humphrey, president, Tide Water Associated Oil Company, San Francisco, California. In addition, the following individuals have been named to committee membership: Eric V. Weber, president, Eureka Oil Company, Cincinnati, Ohio; Jacob France, president, Mid-Continent Petroleum Corporation, Tulsa, Oklahoma; R. van der Woude, president, Shell Union Oil Corporation, New York City; H. F. Sinclair, president, Consolidated Oil Corporation, New York City, and Dr. Robert E. Wilson, president, Pan-American Petroleum and Transport Company, New York City.

The committee is authorized to designate a sub-committee of technical men if desired.

J. R. Parten Heads Transportation Division

Official announcement of the appointment of Jubal R. Parten, of Houston, Texas, as director of the Transportation Division, Office of Petroleum Coördinator, has been made by Deputy Coördinator Ralph K. Davies.

Parten succeeds Henry A. Gilbert, who takes over a new assignment as special assistant to the Deputy Coördinator. He has been head of the Transportation Division since last July.

For several months Parten has been a member of the Tanker Coördinating Board, the joint government-industry organization set up by the Office of Petroleum Coördinator and the United States Maritime Commission to coördinate the operations and use of United States oil tankers. He will continue to serve on the Board, but in his new capacity as a representative of government, rather than of industry.

He joins the Coördinator's staff on leave of absence as president of the Woodley Petroleum Company, of Houston, Texas, and as chairman of the board of directors of the Premier Oil Refining Company of Texas, which operates refineries at Longview, Texas, Fort Worth, Texas, and Cotton Valley, Louisiana. Both are companies he helped organize.

Parten is a native of Madison County, Texas. He is a past president of the Independent Petroleum Association of America and for many years has been a member of both the American Petroleum Institute and the Mid-Continent Oil and Gas Association. From 1935 to 1941 he was a member and, for two years, chairman, of the Board of Regents of the University of Texas.

MEETINGS

American Institute of Mining and Metallurgical Engineers—April 15, 16, and 17, Cincinnati, Ohio.

National Petroleum Association, Thirty-ninth Semi-Annual Meeting—April 16 and 17, Hotel Cleveland, Cleveland, Ohio.

American Chemical Society, 103rd Meeting—April 20, 21, 22, 23, and 24, Memphis, Tennessee.

Southwestern Gas Measurement Short Course—April 21, 22, and 23, University of Oklahoma, Norman, Oklahoma.

American Association of Petroleum Geologists, Twenty-seventh Annual Meeting—April 21, 22, 23, and 24, Cosmopolitan Hotel, Denver, Colorado.

Petroleum Industry Electrical Association—April 22, 23, and 24, Shreveport, Louisiana.

The American Association of Petroleum Geologists, The Society of Economic Paleontologists and Mineralogists, The Society of Exploration Geophysicists, and The Rocky Mountain Association of Petroleum Geologists, joint Annual Convention — April 22, 23, and 24. Cosmopolitan Hotel, Denver, Colorado.

Independent Petroleum Association of America, Mid-Year Meeting of Directors—April 23 and 24, Fort Worth, Texas.

American Gas Association, Natural Gas Section, Annual Convention—May 4, 5, 6, and 7, New Orleans, Louisiana.

California Natural Gasoline Association, Monthly Meeting—May 7, Barker Bros. Auditorium, 818 West Seventh Street, Los Angeles, California.

American Institute of Chemical Engineers—May 11, 12, and 13, Boston, Massachusetts.

Natural Gasoline Association of America — May 14 and 15, Mayo Hotel, Tulsa, Oklahoma.

American Petroleum Institute, 12th Mid-Year Meeting—May 25, 26, 27, 28, and 29, Oklahoma City, Oklahoma. (Cancelled)

Illinois-Indiana Petroleum Association and Illinois Basin Chapter of American Petroleum Institute, Joint Petroleum Conference—June 6, Robinson, Illinois.

American Society of Mechanical Engineers, Semi-Annual Meeting—June 8, 9, 10, and 11, Cleveland, Ohio.

American Society for Testing Materials—June 22, 23, 24, 25, and 26, Chalfonte-Haddon Hall, Atlantic City, New Jersey.

Indiana Independent Petroleum Association, Fall Meeting—September 14 and 15.

Texas Mid-Continent Oil and Gas Association—October 8, 9, and 10, Dallas, Texas.

National Stripper Well Association, Annual Meeting—October 12, Wichita, Kansas.

American Society of Mechanical Engineers, Fall Meeting—October 12, 13, and 14, Rochester, New York.

Independent Petroleum Association of America, 13th Annual Meeting—October 13, 14, and 15, Wichita, Kansas.

National Lubricating Grease Institute, Tenth Annual Meeting—October 25, 26, 27, 28, and 29, New Orleans, Louisiana.

Illinois Mineral Industries Conference—October 30 and 31, Urbana, Illinois.

American Petroleum Institute, Annual Meeting — November 9, 10, 11, 12, and 13, Chicago, Illinois.

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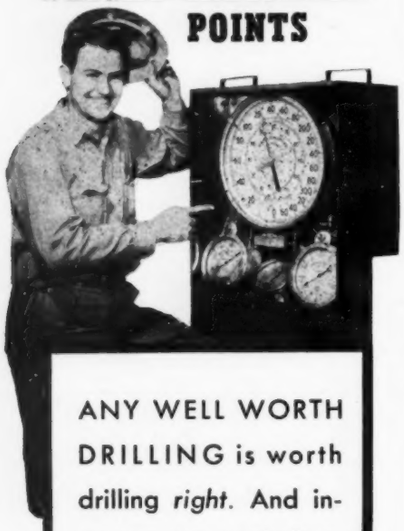

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